W9ELQ
XMTR

Jim: 6/10/88

MIKE, W9ELQ designed and built this rig sometime between 1942-1950.

We graduated together in 1942 (UW EE). He was a few years older than the rest of us (and still is), and was hired by the owner of "Operadio", now DuKane and served with Roger Robbins (another EE '42) in various engineering + administrative capacities.

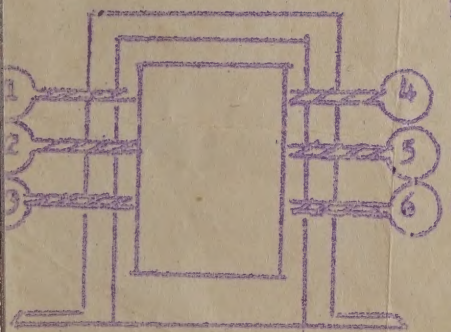
I think he'd be happy to know that the rig has a good home and may continue to provide some of the enjoyment I've had with it. I once got a report of "broadcast quality" on AM, 15 meters.

'73 Norb.

In Modulator

PRIMARY 120 V 50/60 CYCLES

TYPE	VOLTAGES AND CURRENT AVAILABLE		
4P222	2 - 2.5V @ 2A	2.5V @ 4A	5V @ 2A
4P227	2 - 2.5V @ 5A	2.5V @ 10A	5V @ 5A
4P234	2 - 2.5V @ 7.5A	2.5V @ 15A	5V @ 7.5A
4P239	2 - 5V @ 3.25A	5V @ 6.5A	10V @ 3.25A
4P243	2 - 5V @ 10A	5V @ 20A	10V @ 10A
4P244	SINGLE SECONDARY	6.3V @ 0.6A	
4P246	2 - 6.3V @ 1A	6.3V @ 2A	12.6V @ 1A
4P251	2 - 6.3V @ 3A	6.3V @ 6A	12.6V @ 3A
4P256	2 - 6.3V @ 5A	6.3V @ 10A	12.6V @ 5A
4P260	2 - 7.5V @ 1.5A	7.5V @ 3A	15V @ 1.5A
4P267	2 - 7.5V @ 2.25A	7.5V @ 4.5A	15V @ 2.25A
4P272	2 - 11V @ 5A	11V @ 10A	22V @ 5A
	CONNECT FIL. TO 1-3 AND 4-6.	CONNECT FIL. TO 1-3 WITH 1 CONNECTED TO 4 AND 3 TO 6.	CONNECT FIL. TO 1-6 WITH 3-4 JOINED AS C.T.



BLK

BRN

BLK

2 AND 5 CONNECTED AS C.T.

SNC MANUFACTURING CO., INC.
POST OFFICE BOX 277
OSHKOSH, WISCONSIN

IN MODULATOR

- METAL SHOP -
MATERIAL

Name _____

Date _____

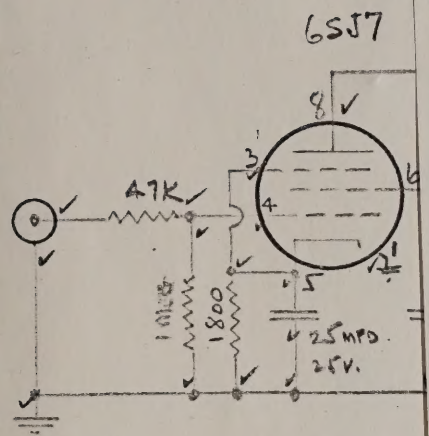
Weight	Kind	Price

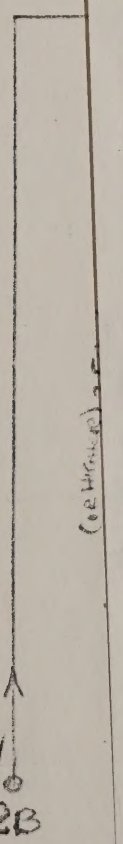
Put 50-100 Ω Resistors
in series with 813 Plates

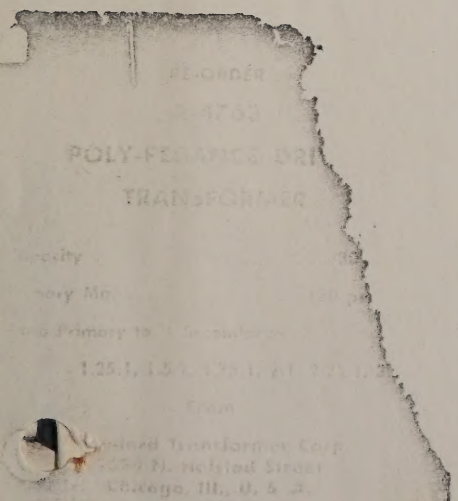
MODULATOR

(0.3

H = 2

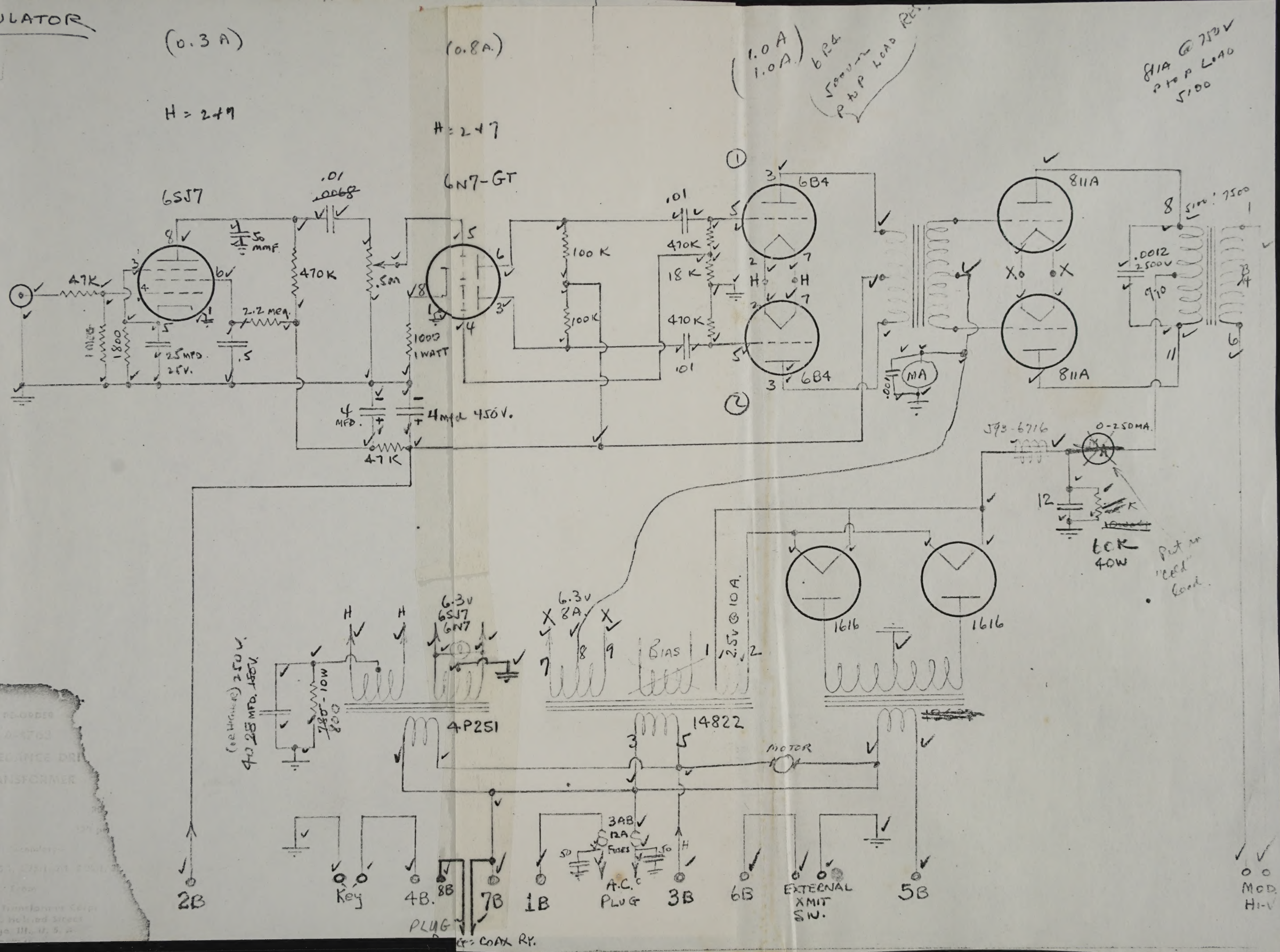






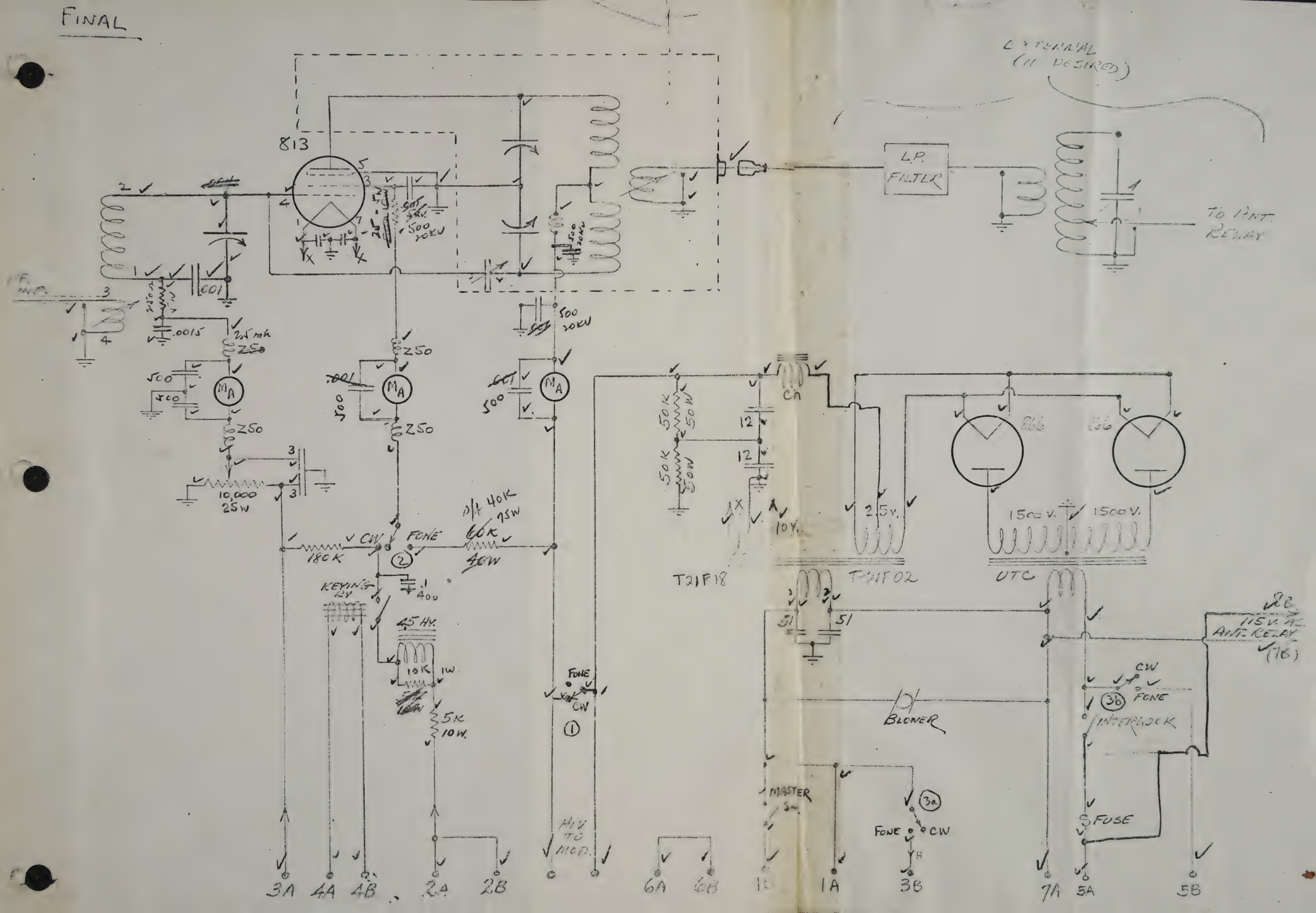
Put 50-100 Ω Resistors
in series with the Plates

MODULATOR

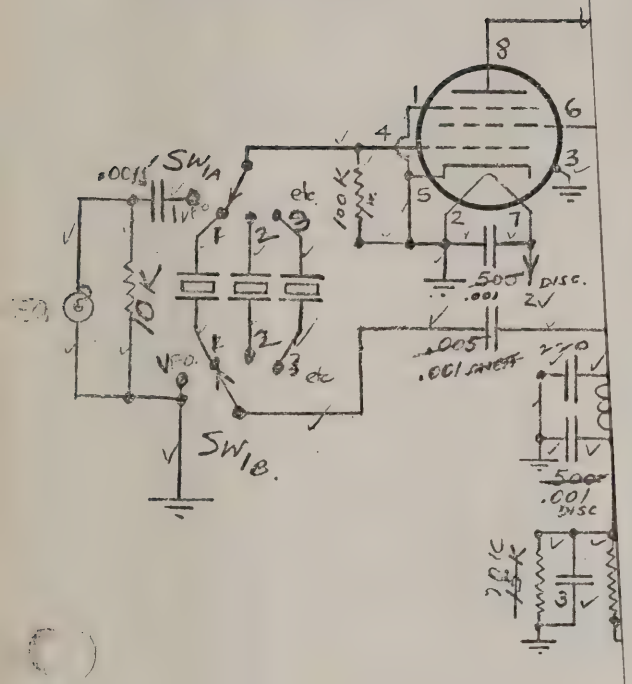


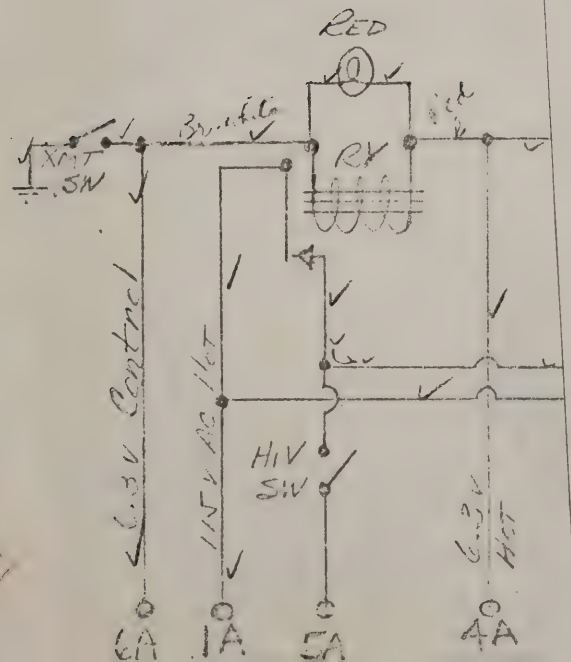
RE-ORDER
A-4702
POLY-PHASE DRIVE
TRANSFORMER
Quality
Factory No.
Ratio Primary to Secondary
1.25:1, 1.5:1, 2.75:1, 3.25:1, 3.75:1
From
Standard Transformer Corp.
1580 N. Halsted Street
Chicago Ill., U. S. A.

FINAL

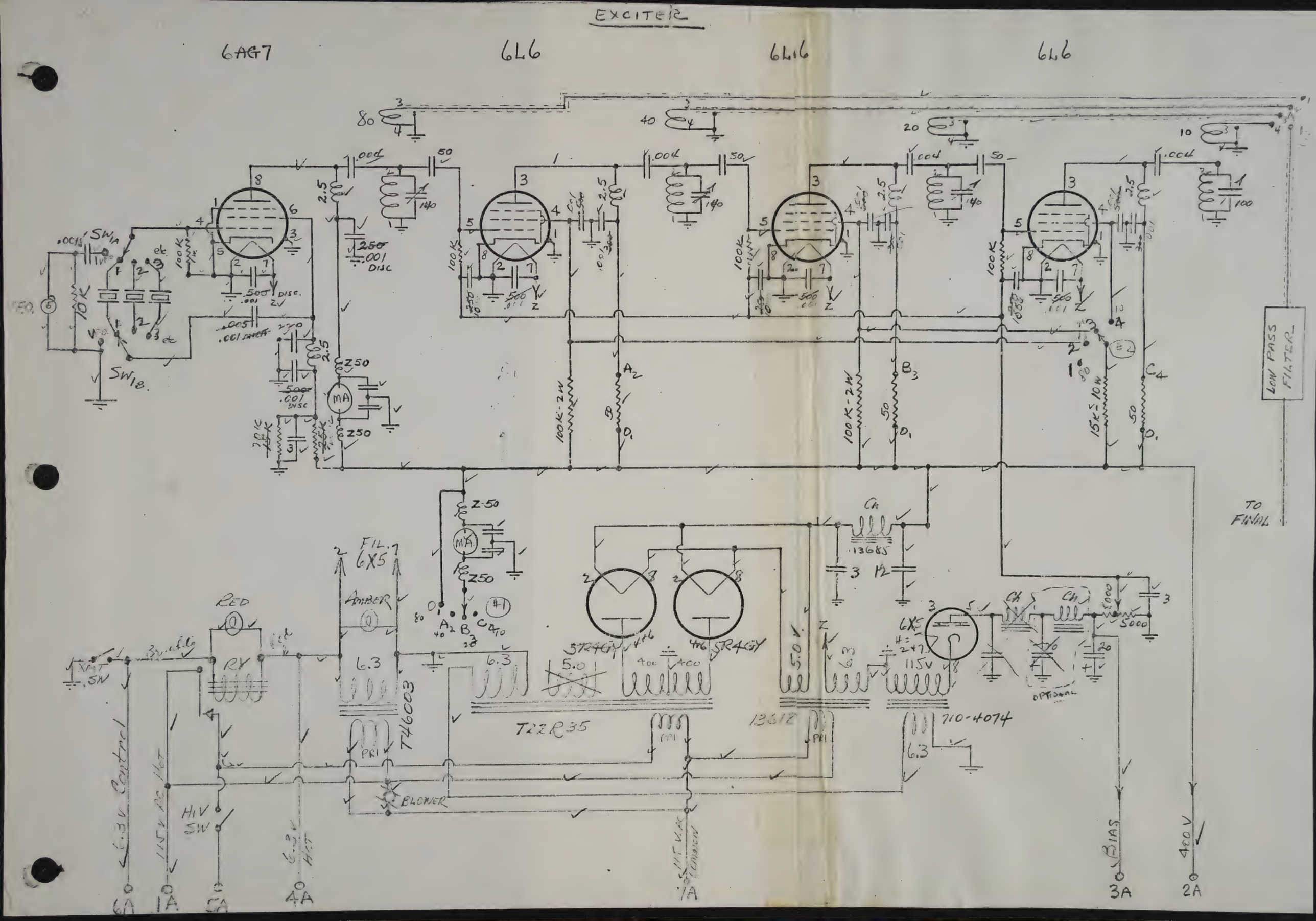

EXTERNAL (IF DESIRED)
813
L.P. FILTER
TO ANT. RELAY
.001
.0015
25 mh
250
500
400
MA
10,000 25W
180K
CW
FONE
40K 75W
60K 40W
KEYING RY
45 HY.
12K 1W.
5K 10W.
500 10KV
HV TO MOD.
50K 50W
12
1X
10V.
Ch
2.5V.
1500 V.
T21F18
T21F02
UTC
51
BLOWER
115 V. AC ANT. RELAY (16)
INTERLOCK
MASTER SW.
FUSE
3A 4A 4B 2A 2B 6A 6B 1B 1A 3B 7A 5A 5B

6AG7


SW1A
SW1B
.0015
VFO
etc
10K
500
.001
DISC.
2V
.005
.001 SHEET
270
500
.001
DISC
20K
8
6
4
3
5
2
7
1


RED
XMT
SW
RY
6.3V Control
115V Reg Hot
HIV
SW
6.3V
Hot
6A
1A
5A
4A

EXCITER


6AG7
6L6
6L6
6L6
80
40
20
10
SW1A
SW1B
VFO
10K
100K
.0015
.004
50
2.5
140
100
250
.001 DISC
500
.001
.005
.001 SHORT
Z50
MA
100K-2W
A2
B2
D1
B3
C4
15K-10W
LOW PASS FILTER
TO FINAL
Z-50
FIL.
6X5
AMBER
RED
RY
6.3
T46003
5R4GY
5.0
T22R35
PRI
BLOWER
13685
13612
6X5
115V
710-4074
OPTIONAL
5000
BIAS
400 V
6A
1A
5A
4A
1A
3A
2A
6.3V Control
115V AC Hot
HIV SW
6.3V Hot
115V AC Hot Common

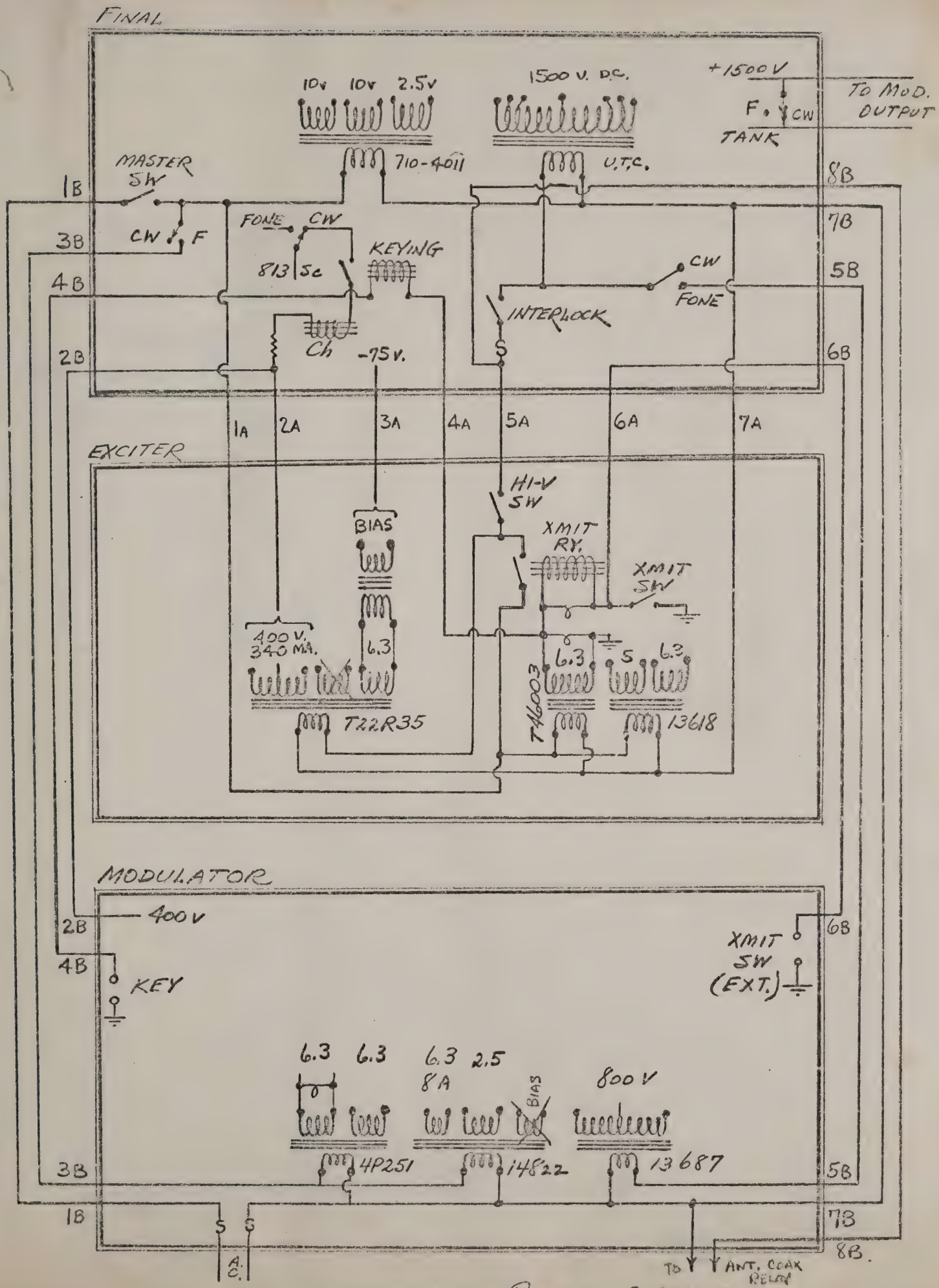
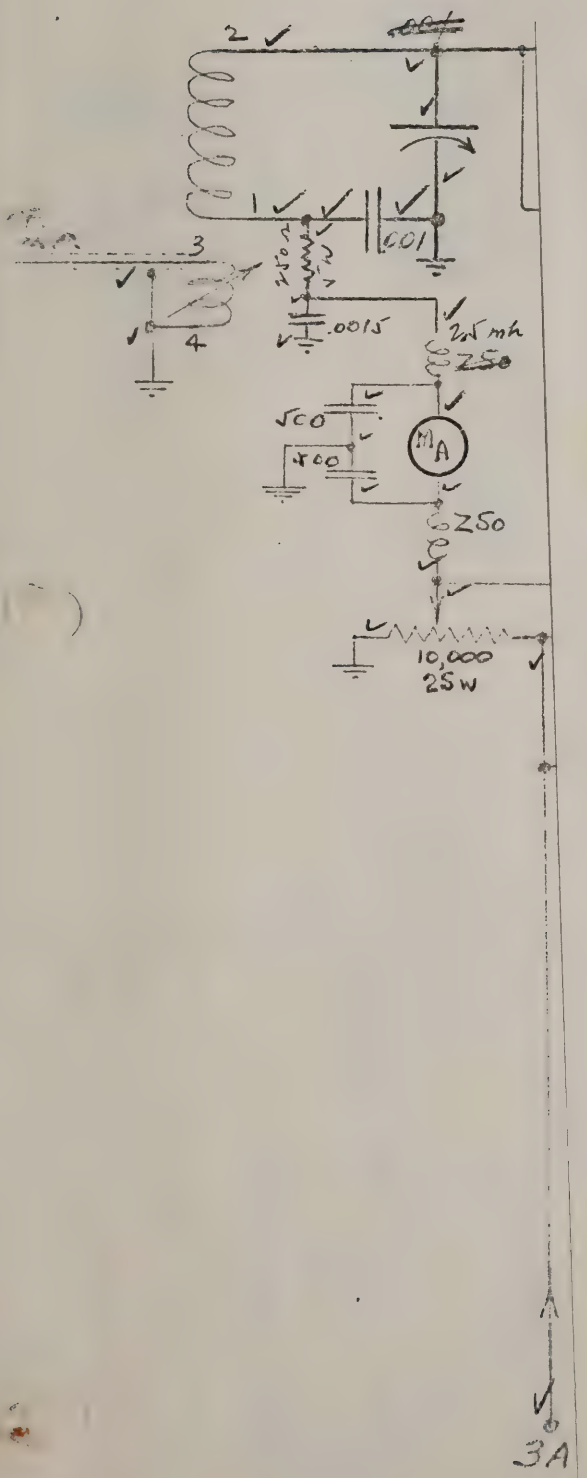
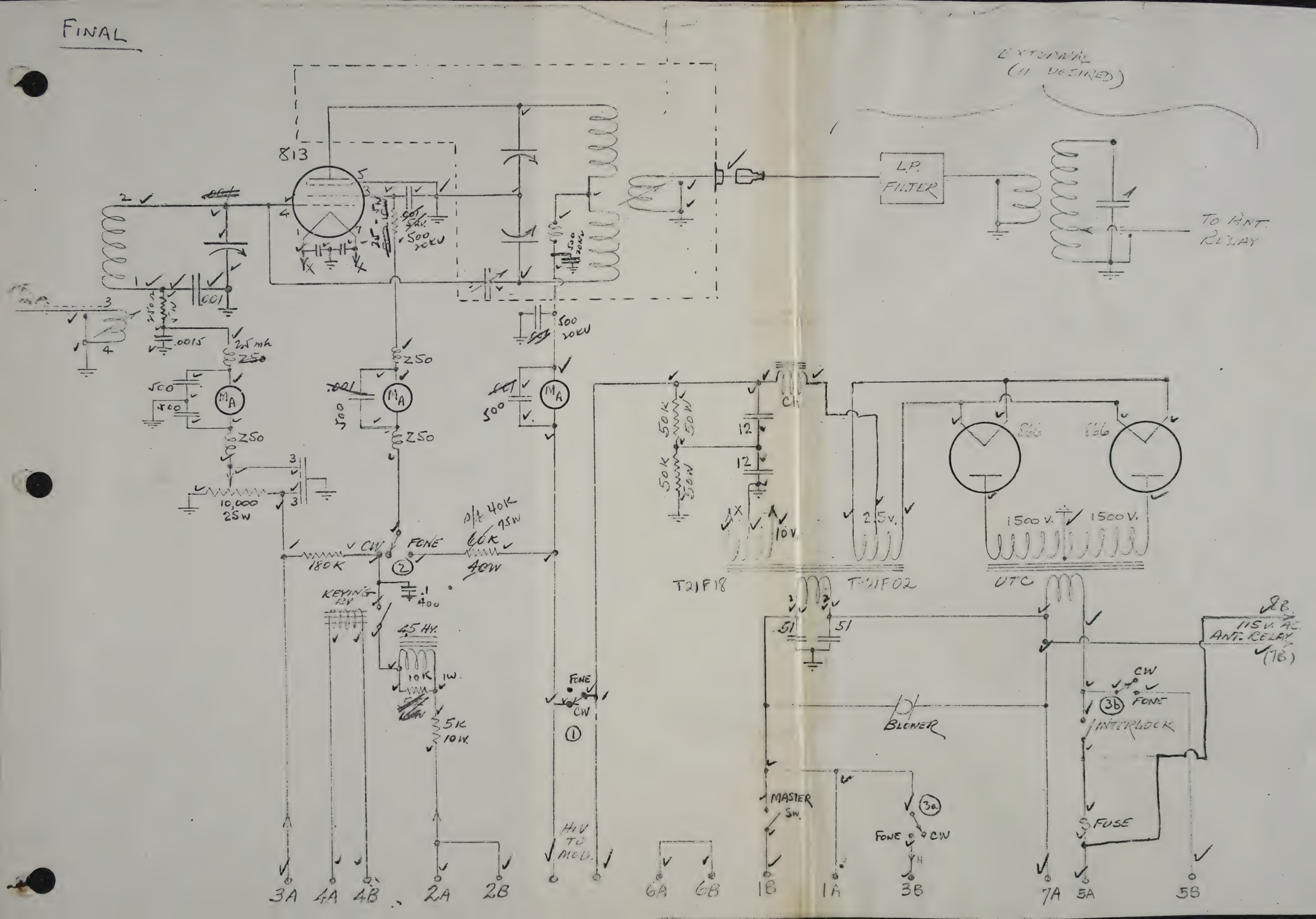


DIAGRAM - POWER CIRCUITS

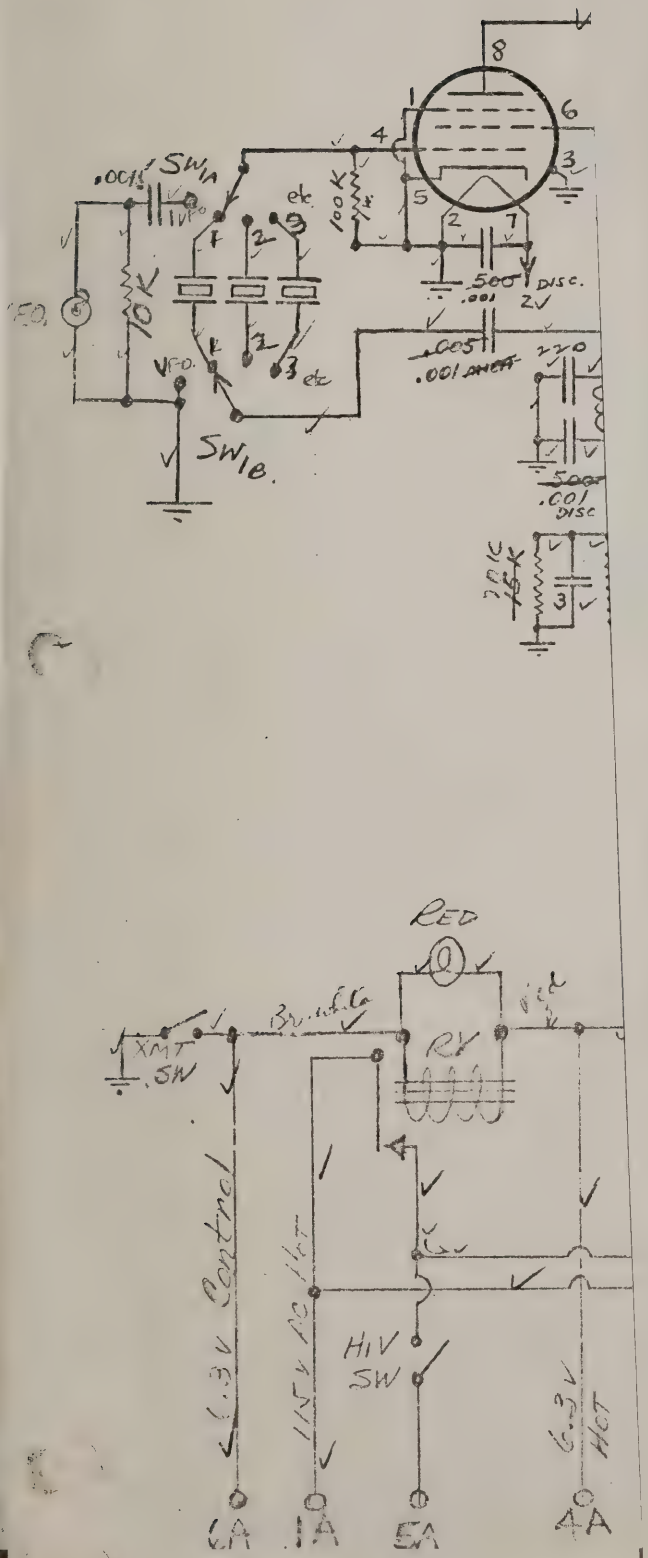
FINAL



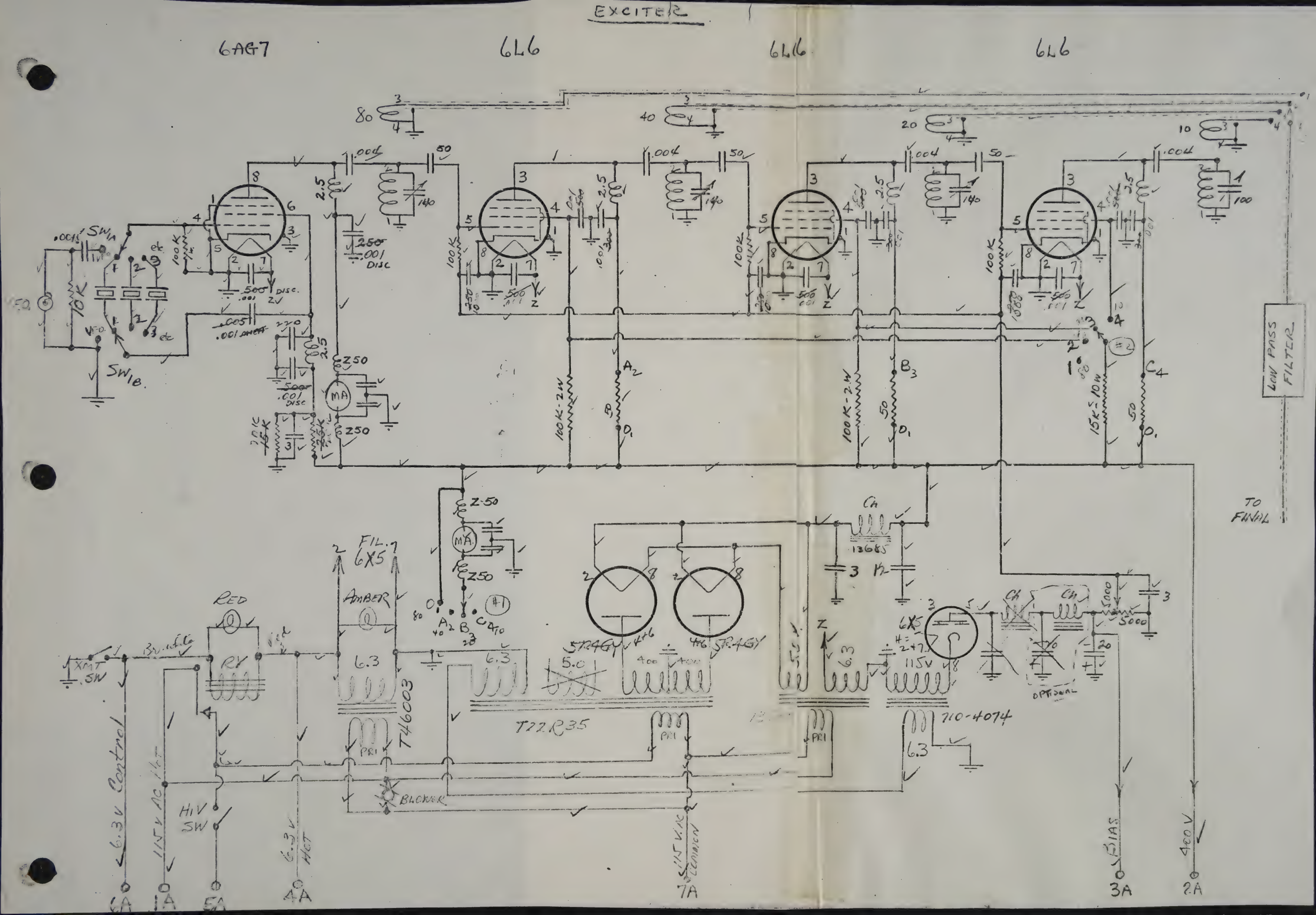
FINAL


EXTERNAL (IF DESIRED)
813
L.P. FILTER
TO ANT. RELAY
.001
.0015
2½ mh
250
500
10,000 25W
180K
CW
FONE
40K 75W
60K 40W
KEYING RY
400
45 HV.
10K 1W.
5K 10W.
HIV TO MOD.
3A 4A 4B 2A 2B
50K 50W
12
10V.
2.5V.
T21F18
T-41F02
866
1500 V.
UTC
51
BLOWER
115 V. AC ANT. RELAY (7B)
INTERLOCK
FUSE
MASTER SW.
6A 6B 1B 1A 3B 7A 5A 5B

6AG7


SW1A
.001
VFO
10K
etc.
100K
.500
.001
DISC.
2V
.005
.001 ANCH
220
.500
.001
DISC
SW1B.
RED
XMT SW
RY
Control
115V AC HOT
HIV SW
6.3V HOT
6A
1A
5A
4A

EXCITER


6AG7
6L6
6L6
6L6
80
40
20
10
SW1A
SW1B
VFO
10K
100K
.004
50
140
2.5
250
.001 DISC
500
.001
DISC.
2V
.005
.001 DISC
220
.001 DISC
Z50
MA
100K-2W
A2
B3
D1
100K-2W
50
15K-10W
C4
LOW PASS FILTER
TO FINAL
Z-50
FIL.
6X5
RED
AMBER
RY
XMT SW
6.3
T46003
PRI
BLOWER
5T4GY
5.0
400
T22R35
Ch
13665
3
6X5
115V
710-4074
OPTIONAL
5000
BIAS
400 V
6.3 V Control
115 V AC HOT
HIV SW
6.3 V HOT
115 V AC COMMON
6A
1A
5A
4A
7A
3A
2A

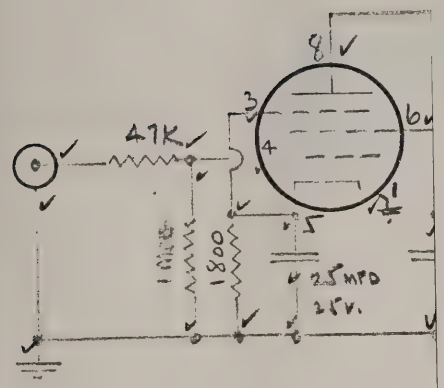
Pt for 8B	≈ 150	0V (1250, 100)	300 mA
exciter	+400	275 mA	
mod	+800	340 mA	
	+635	30 mA	

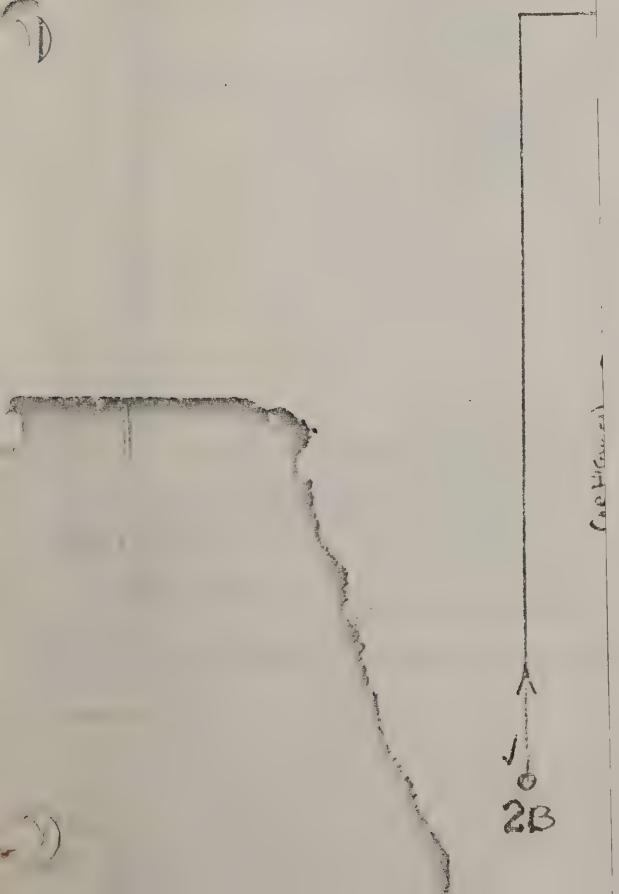
MODULATOR

(0.3 f

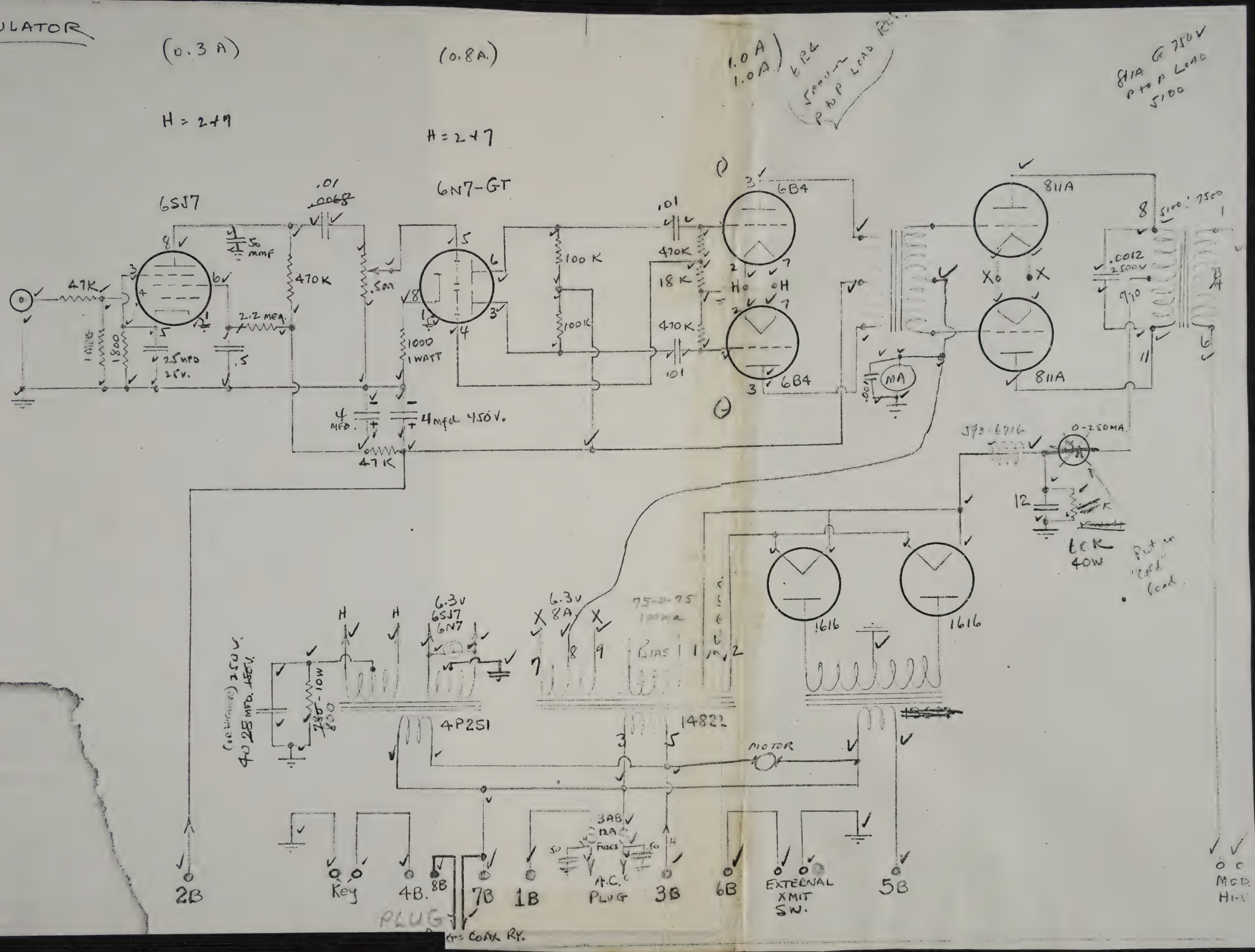
H = 24

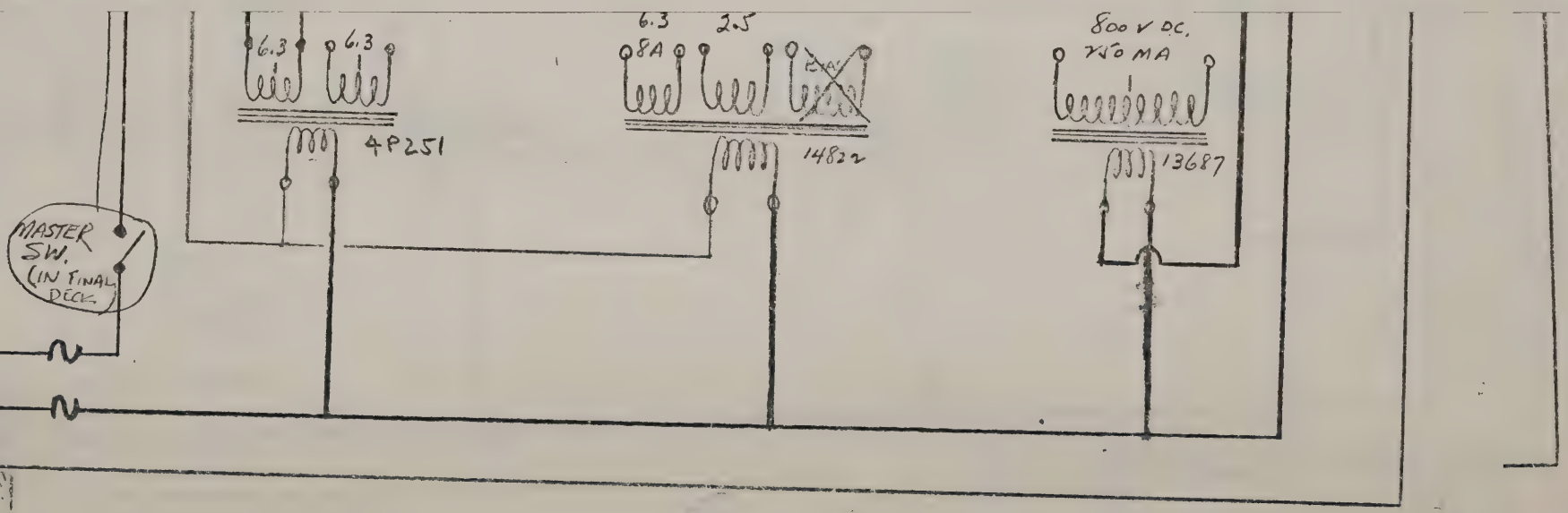
6SJ7

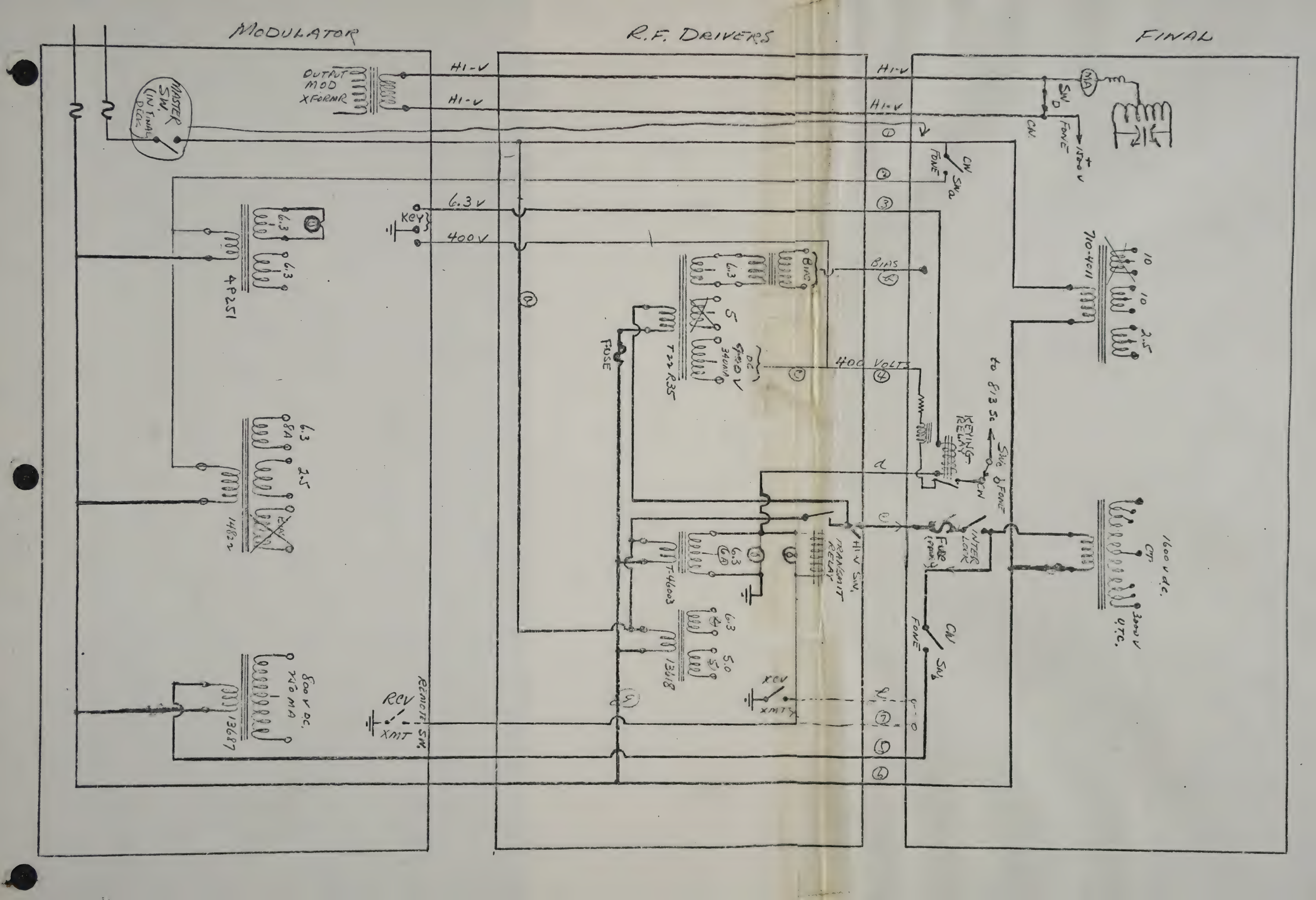




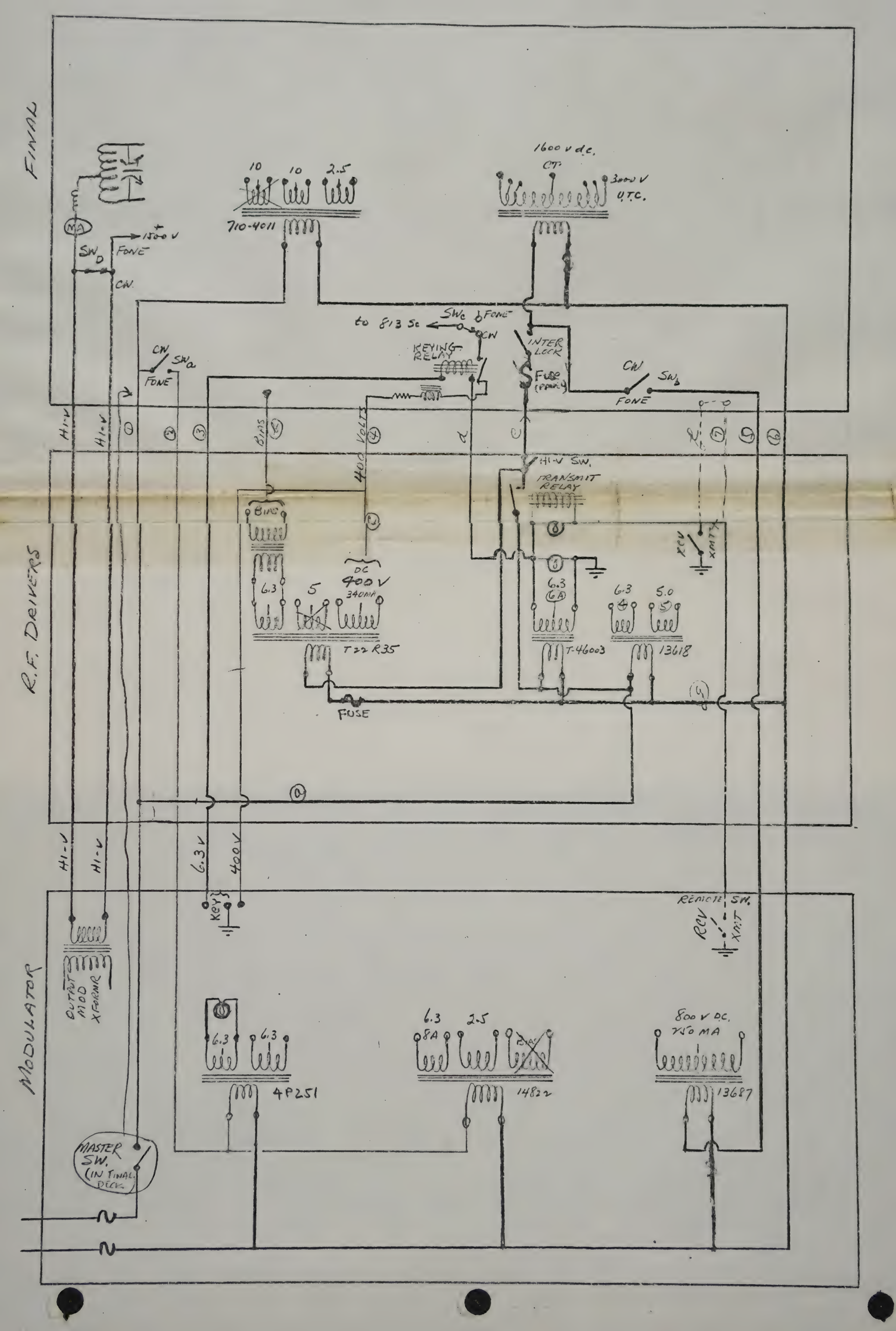
MODULATOR


(0.3 A)
(0.8A.)
1.0 A
1.0 A
6B4
5000 ~
P to P LOAD
811A @ 750V
P to P LOAD
5100
H = 2+7
H = 2+7
6SJ7
6N7-GT
6B4
811A
47K
470K
.5M
2.2 meg.
1000
1 WATT
100 K
100K
470K
18 K
470K
.01
.0012
2500V
9-10
SEC: 750
MA
4 MFD.
4 mfd 450V.
47K
0-250MA
12
60K
40W
Put on "cold" load
6.3V
6SJ7
6N7
6.3V
8A
75-0-75
1 mfa
BIAS
1616
1616
4P251
14822
MOTOR
(Oil filled) 250V.
40 25 MFD. 150V.
780-10W
3AB
12A
FUSES
A.C.
PLUG
2B
Key
4B.
8B
7B
1B
3B
6B
EXTERNAL
XMIT
SW.
5B
MOD.
HI-V
PLUG
COAX RY.


6.3
6.3
4P251
6.3
8A
2.5
14822
800 V DC.
140 MA
13687
MASTER SW.
(IN FINAL DECK)

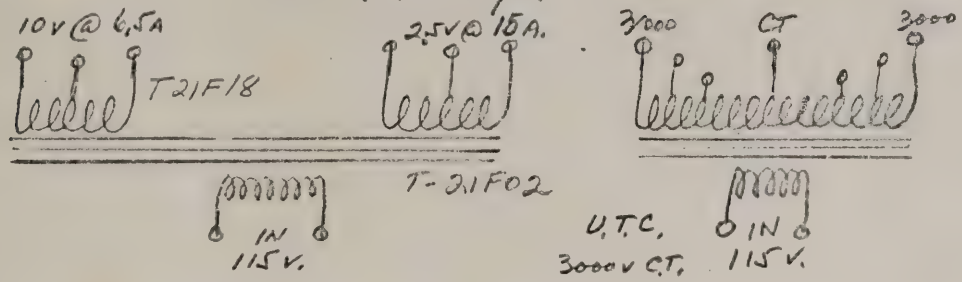

MODULATOR
R.F. DRIVERS
FINAL
OUTPUT MOD XFORMR
HI-V
HI-V
MASTER SW. (IN TANK DECK)
6.3 V
KEY
400 V
4P251
6.3
6.3
6.3
2.5
14630
800 V DC. 750 MA
13687
RCV
XMIT
REMOTE SW.
BIAS
400 VOLTS
FUSE
T-22 R35
DC 750 V 340 MA
T-46003
13618
5.0
HI-V SW. TRANSMIT RELAY
KEYING RELAY
INTER LOCK
FUSE
CW
FONE
SW. D
SW. 2
MA
1500 V
710-4011
10
10
2.5
to 813 Sc.
1600 V d.c. CT
3000 V d.c.

MODULA
MASTER SW. (IN TUNING DECK)
6.3
6.3
4P251
6.3
2.5
5A
2.5
14B2
800 V D.C.
250 MA
13B7


FINAL
R.F. DRIVERS
MODULATOR
10
10
2.5
710-4011
1600 v d.c.
CT.
3000 V
U.T.C.
MA
+1500 V
SW D
FONE
CW.
to 813 Sc
SW c
FONE
CW
KEYING RELAY
INTER LOCK
Fuse (Power)
CW
SW a
FONE
CW
SW b
FONE
HI-V
HI-V
BIAS
400 VOLTS
HI-V SW.
TRANSMIT RELAY
BIAS
6.3
5
DC
400 V
340MA
T22 R35
FUSE
6.3
6A
T-46003
6.3
5.0
13618
RCV
XMIT
HI-V
HI-V
6.3 V
400 V
Key
OUTPUT MOD XFORMR
REMOTE SW.
RCV
XMIT
6.3
6.3
4P251
6.3
2.5
8A
14822
800 V D.C.
750 MA
13687
MASTER SW. (IN FINAL DECK)

FINAL

10 Volts	2.5 volts	Plate 3	Screen 1
C13 @ 5.0 Amps.	866A - 5.0 Amps. 866A - 5.0 Amps. total 10.0 Amps.	1600 v. @ 300 ma.	350 v. @ 40 ma

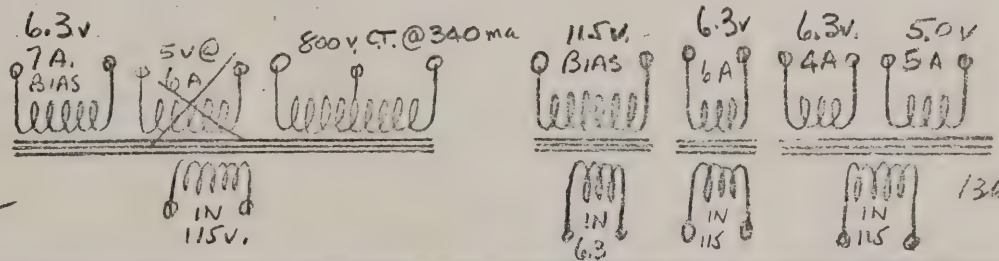


Bias 1

-50v @ 10 ma.

R.F. DRIVERS

6.3 volts.		5.0 volts		Bias 1	Plate 1
6AG7	0.65 Amps.	5R4GY	2.0 Amps.	-50v @ 10ma	350 v @ 160 m
6L6	0.90 "	5R4GY	2.0 "		
6L6	0.90 "	total	4.0 Amps.		
6L6	0.90 "				
total	3.35 Amps.				



#T-2-R35

MODULATOR

6.3 volts		6.3 volts		6.3 volts		2.5 Volts		Plate 1
6SJ7	0.3 Amps.	6B4	1.0 Amp.	811A	4.0 Amps.	1616	5.0 Amps.	350 v @ 12
6SJ7	0.3 "	6B4	1.0 "	811A	4.0 "	1616	5.0 "	
6SC7	0.3 "	total	2.0 Amps.	total	8.0 Amps	total	10.0 Amps.	
6N7	0.8 "							
total	1.7 Amps.							

Plate 2

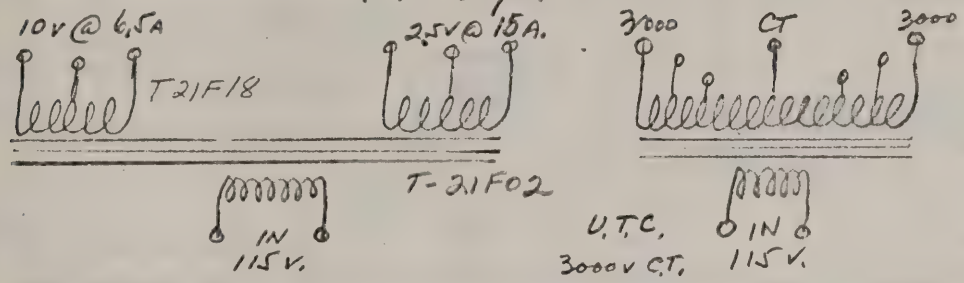
800 v @ 25
1450v.

#14822

#13669

FINAL

10 Volts	2.5 volts	Plate 3	Screen 1
813 @ 5.0 Amps.	866A - 5.0 Amps 866A - 5.0 Amps, total 10.0 Amps.	1600 v. @ 300 ma.	350 v. @ 40 ma

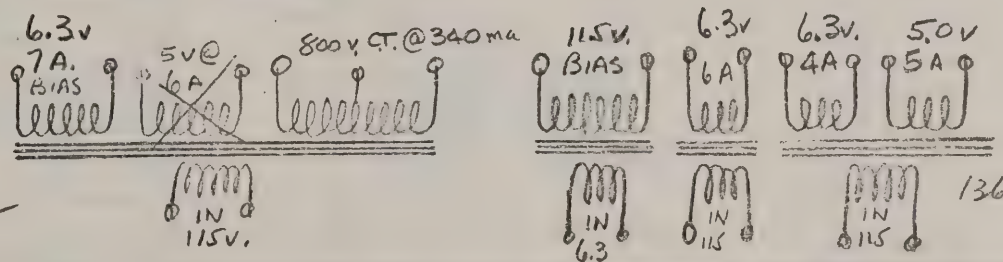


Bias 1

-50v @ 10 ma.

R.F. DRIVERS

6.3 volts.		5.0 volts		Bias 1	Plate 1
6AG7	0.65 Amps.	5R4GY	2.0 Amps.	-50v @ 10ma	350 v @ 160 m
6L6	0.90 "	5R4GY	2.0 "		
6L6	0.90 "	total	4.0 Amps.		
6L6	0.90 "				
total	3.35 Amps.				



#T-V-R 35

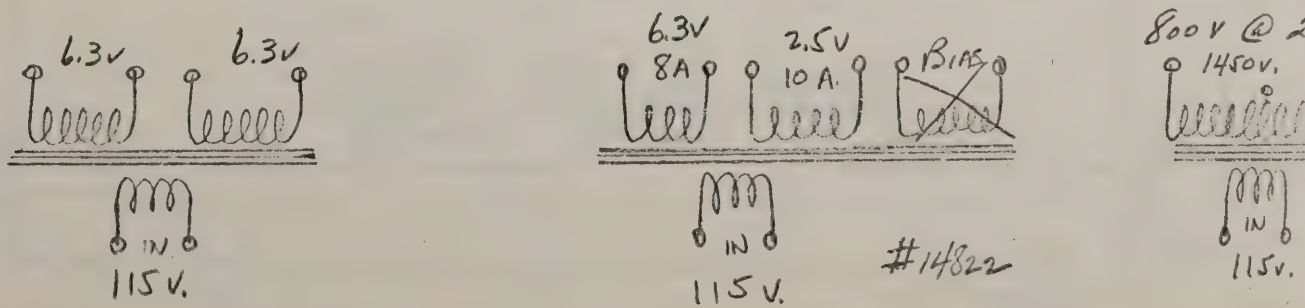
13618

MODULATOR

6.3 volts		6.3 volts		6.3 volts		2.5 volts		Plate 1
6SJ7	0.3 Amps.	6B4	1.0 Amp.	811A	4.0 Amps	1616	5.0 Amps.	350 v @ 1
6SJ7	0.3 "	6B4	1.0 "	811A	4.0 "	1616	5.0 "	
6SC7	0.3 "	total	2.0 Amps,	total	8.0 Amps	total	10.0 Amps.	
6N7	0.8 "							
total	1.7 Amps.							

Plate 2

800 v @ 25



#14822

#13687

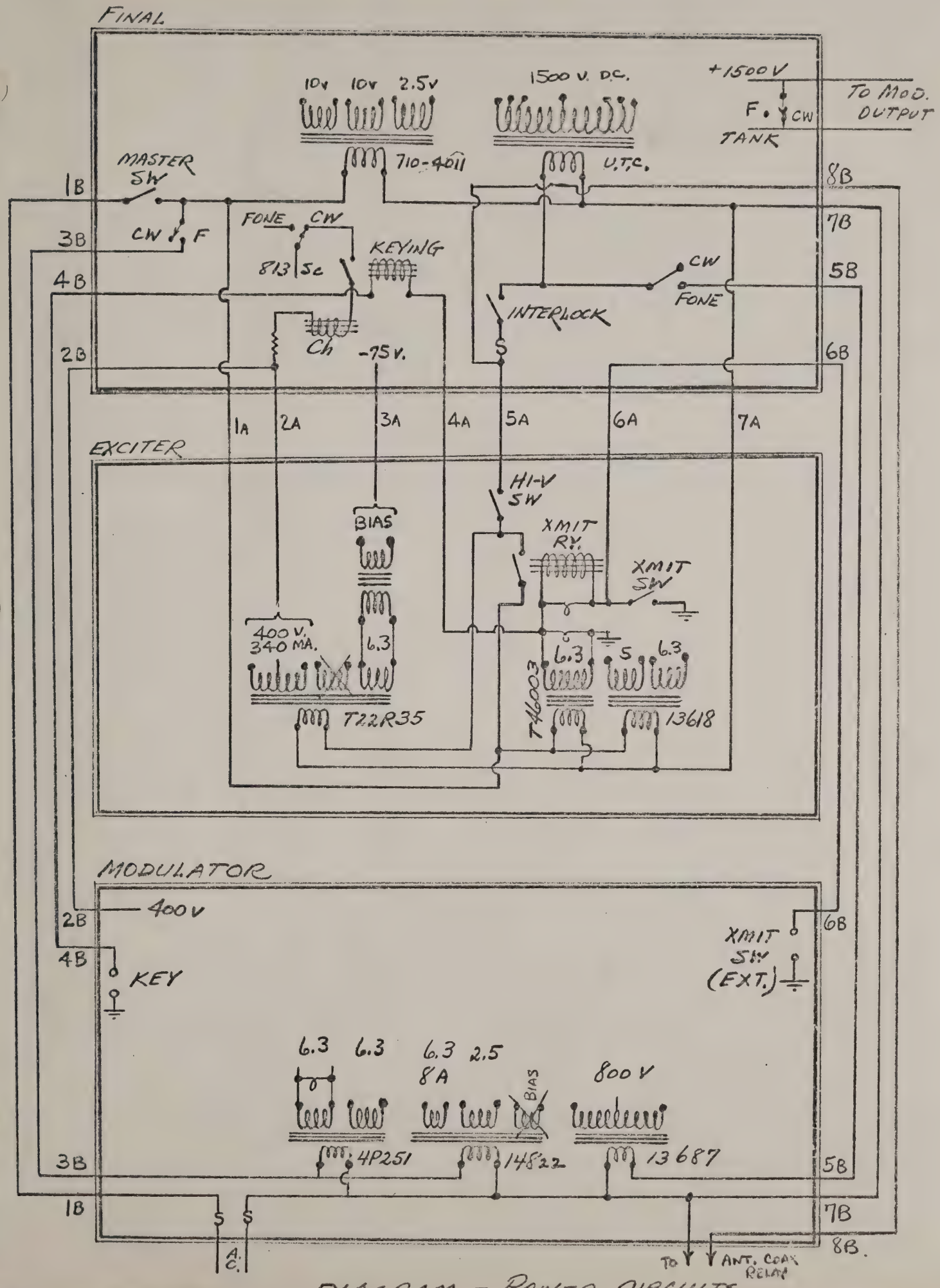
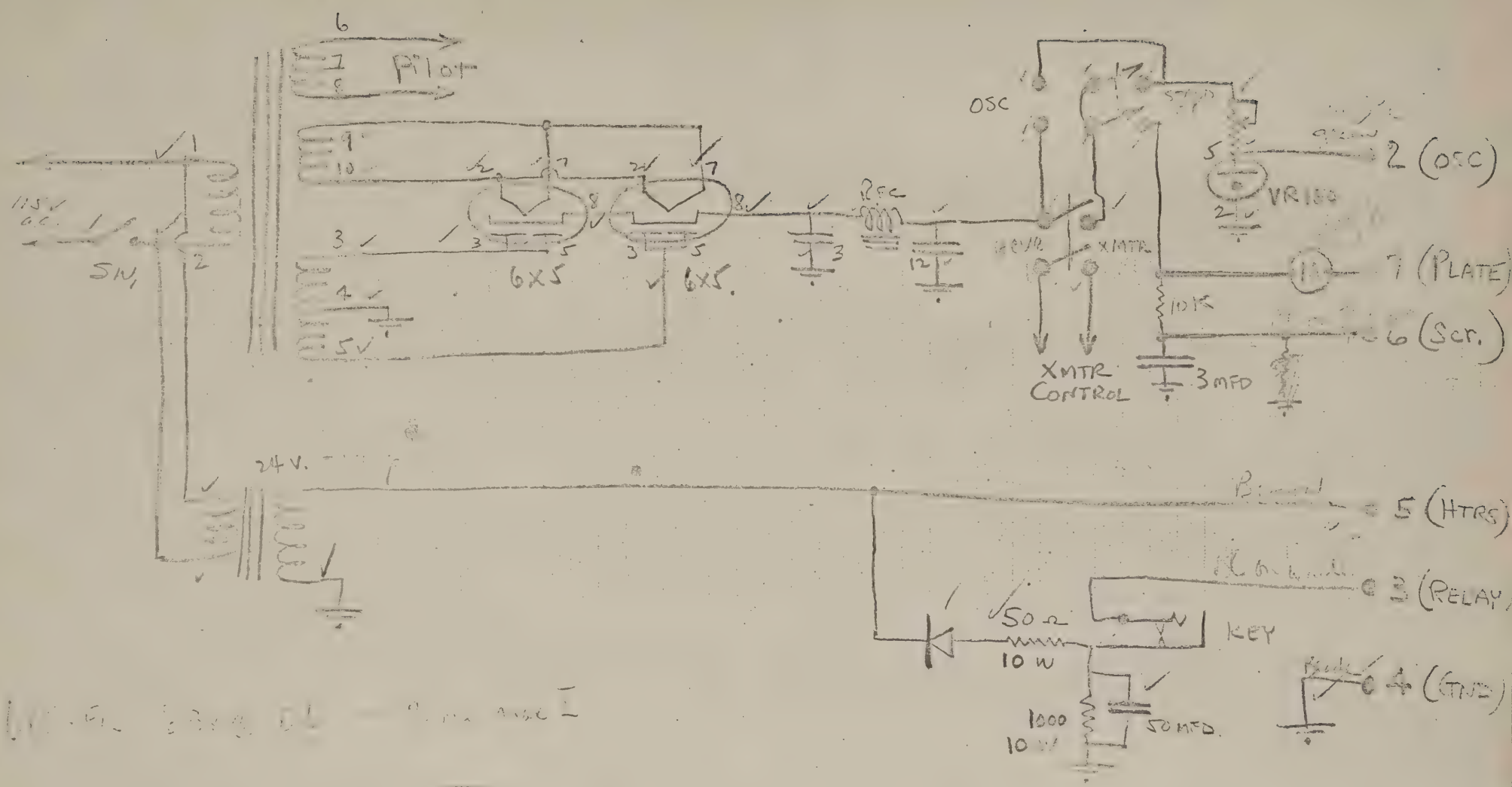
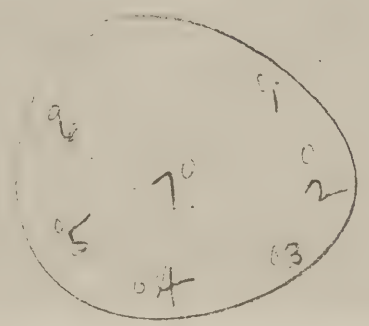


DIAGRAM = POWER CIRCUITS

#14687

6X5 Htr = 6.3V @ 0.6 Amp.





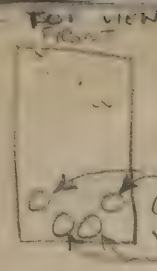
		Fil
1629 (Rec. Indic.)	–	12.6 @ 0.15
1626 – Osc.	–	12.6 @ 0.25
1625 – Pwr Amp.	–	12.6 @ 0.45

$m = \frac{\quad}{\quad}$

$\frac{\quad}{\quad}$

21

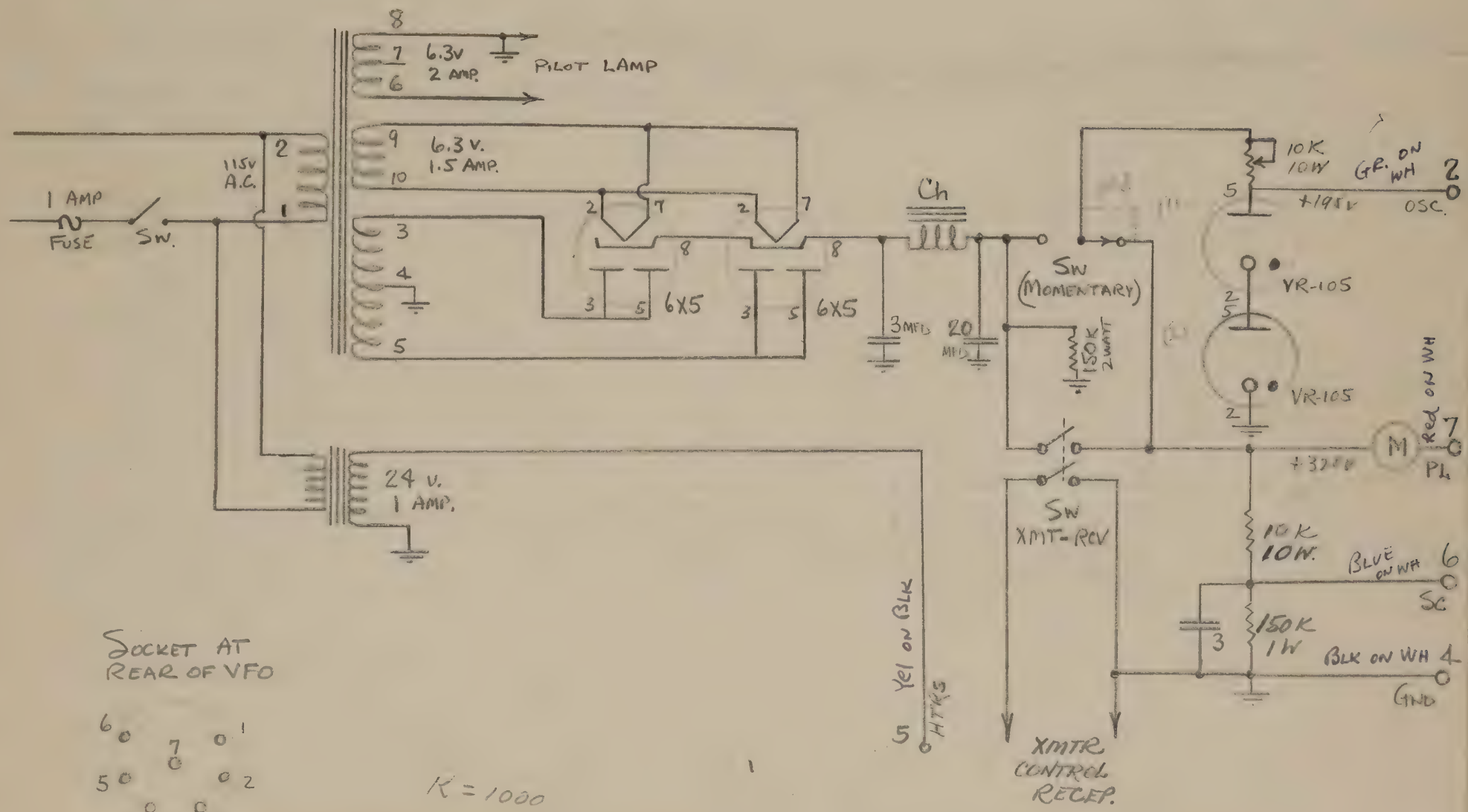
21



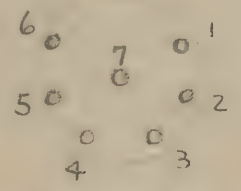
ARC-5 VFO POWER SUPPLY

1629 (EYE) 12.6V @ 0.15 A.
1626 (OSC.) 12.6V @ 0.25 A.
1625 (PWR AMP) 12.6V. @ 0.45A.
6X5 (RECT.) 6.3V @ 0.6 A. (I = 70 MA MAX.)

14687



SOCKET AT REAR OF VFO

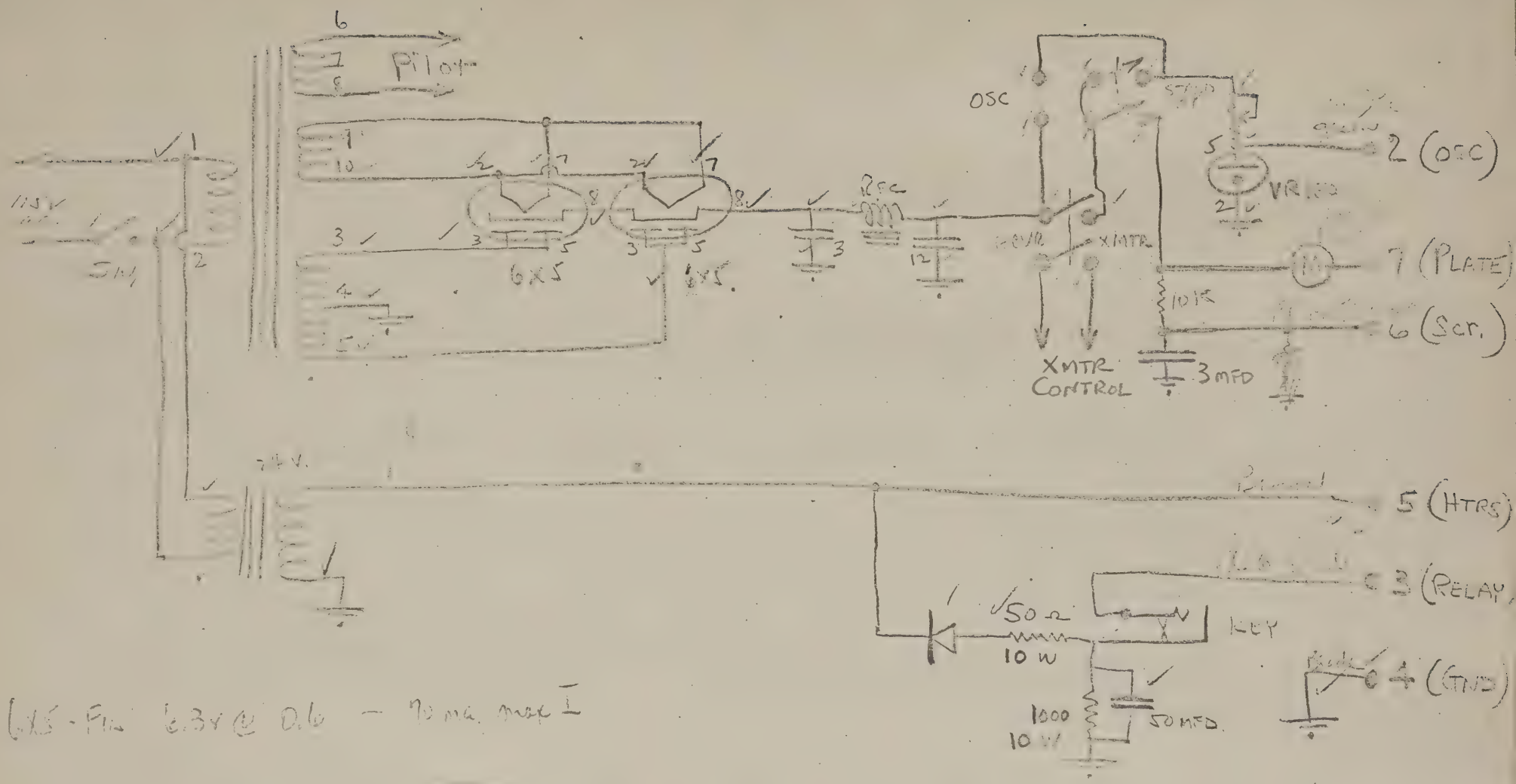


BACK VIEW

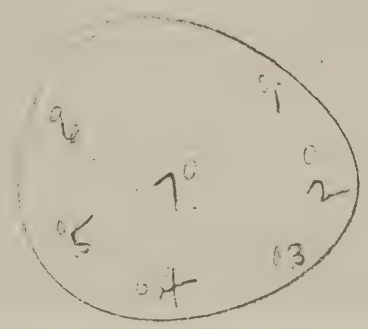
K = 1000

#14687

6X5 Htr = 6.3V @ 0.6 Amp.



6X5 - Fil. 6.3V @ 0.6 — 70 ma. max I

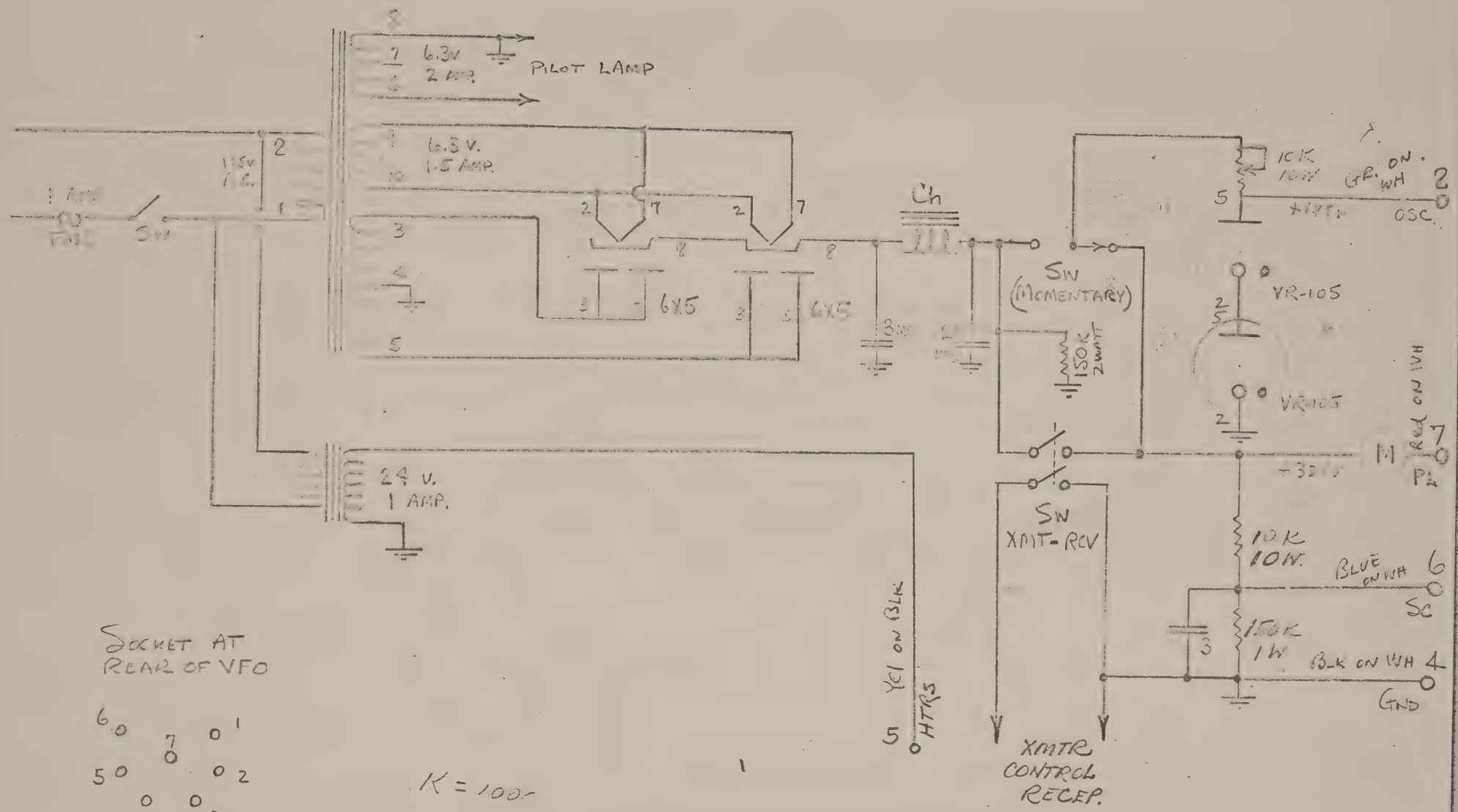


1629 (Rec. Indic.) - Fil. 12.6 @ 0.15
1626 - Osc. - 12.6 @ 0.25
1625 - Pwr Amp. - 12.6 @ 0.45

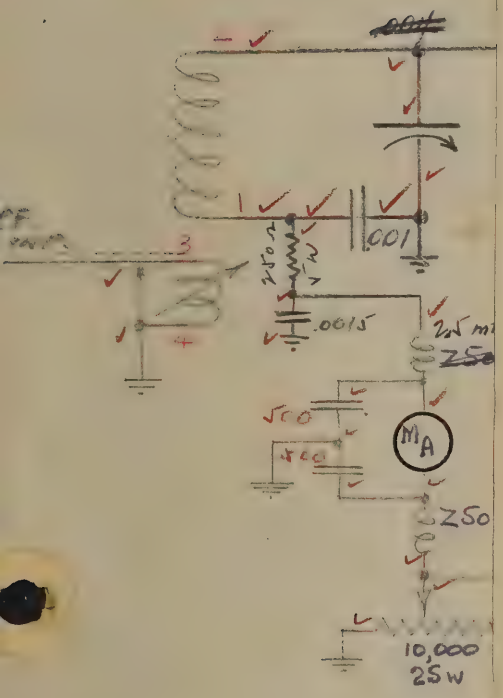
ARC-5 VFO POWER SUPPLY

1629 (EYE) 12.6V @ 0.15 A.
1626 (OSC.) 12.6V @ 0.25 A.
1625 (PWR AMP) 12.6V @ 0.45A.
6X5 (RECT.) 6.3V @ 0.6 A. (70 MA MAX)

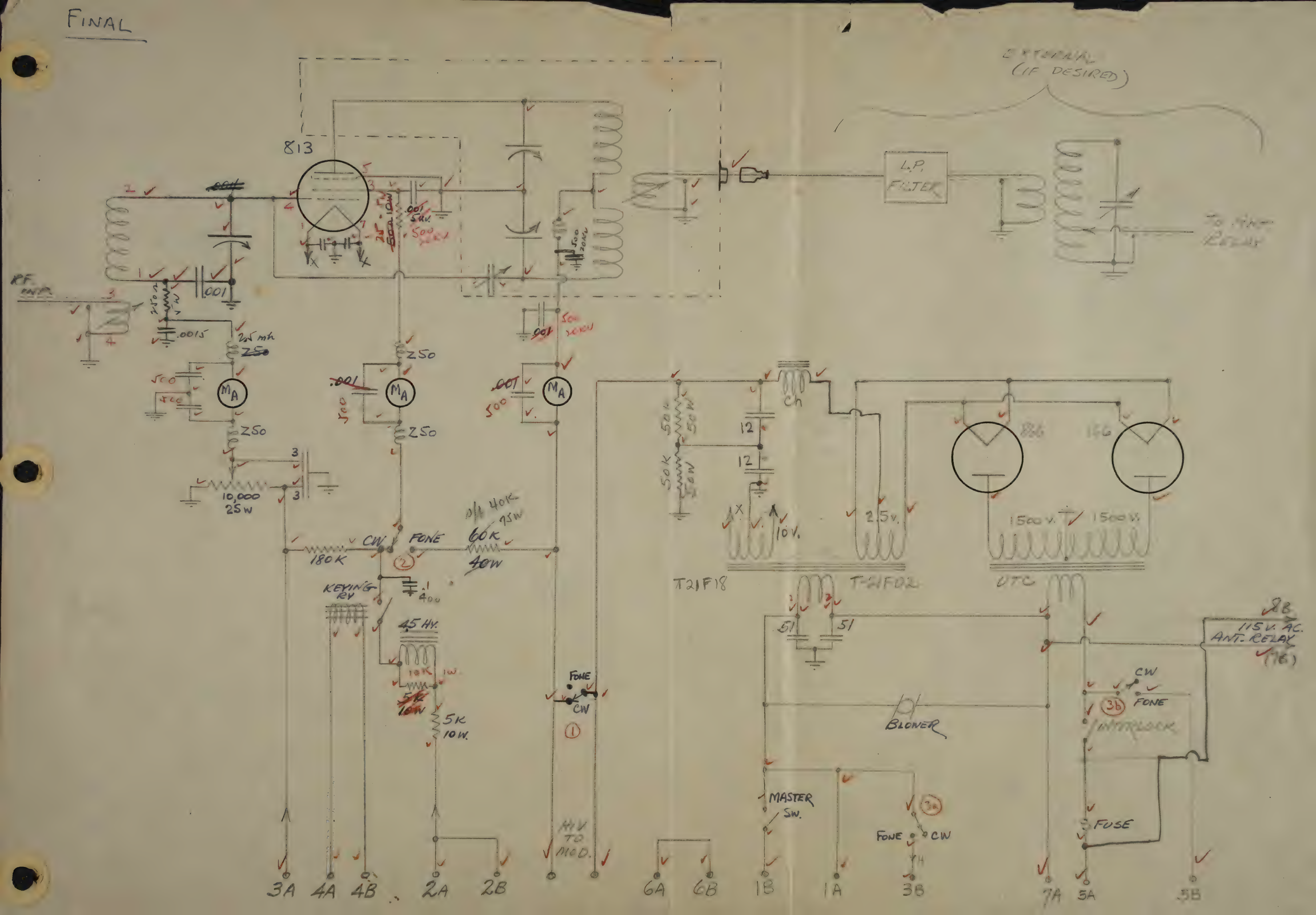
14687

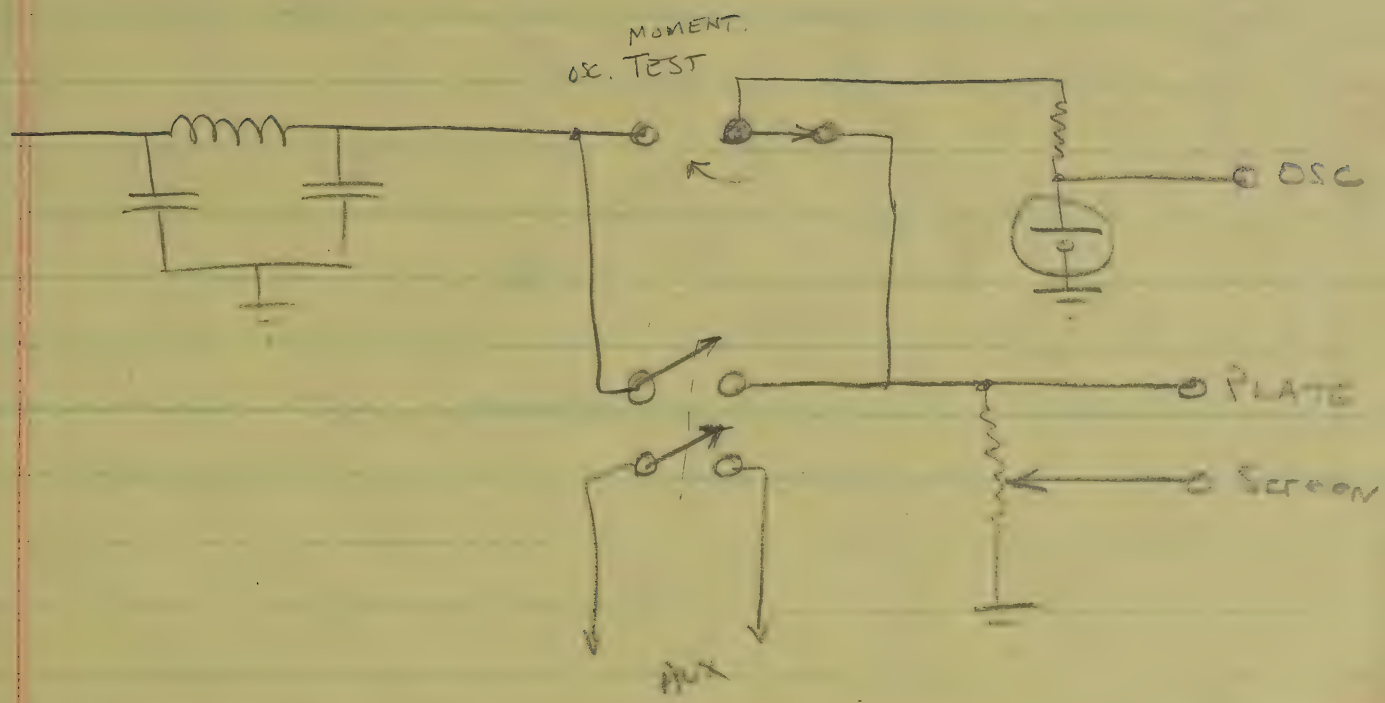


FINAL



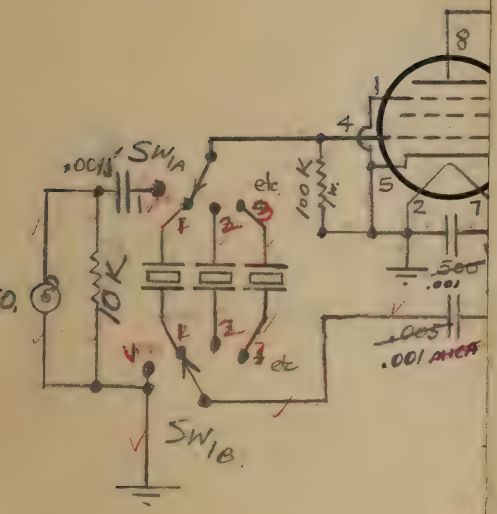
FINAL

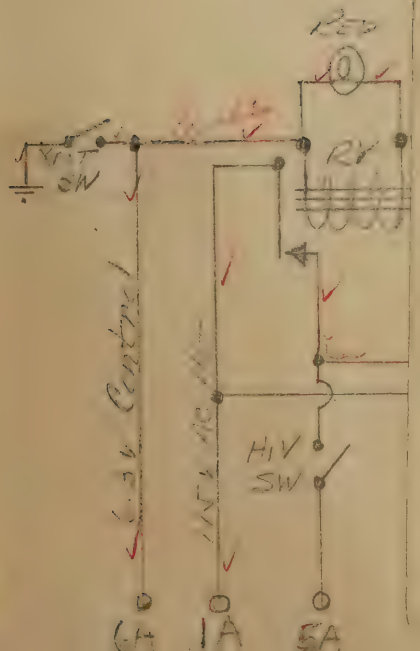

EXTERNAL (IF DESIRED)
813
L.P. FILTER
TO ANT. RELAY
RF INPUT
.001
.001 5KV.
500 20KW
.001 500 20KW
.001 500 20KW
.001 500
.001 500
.001 500



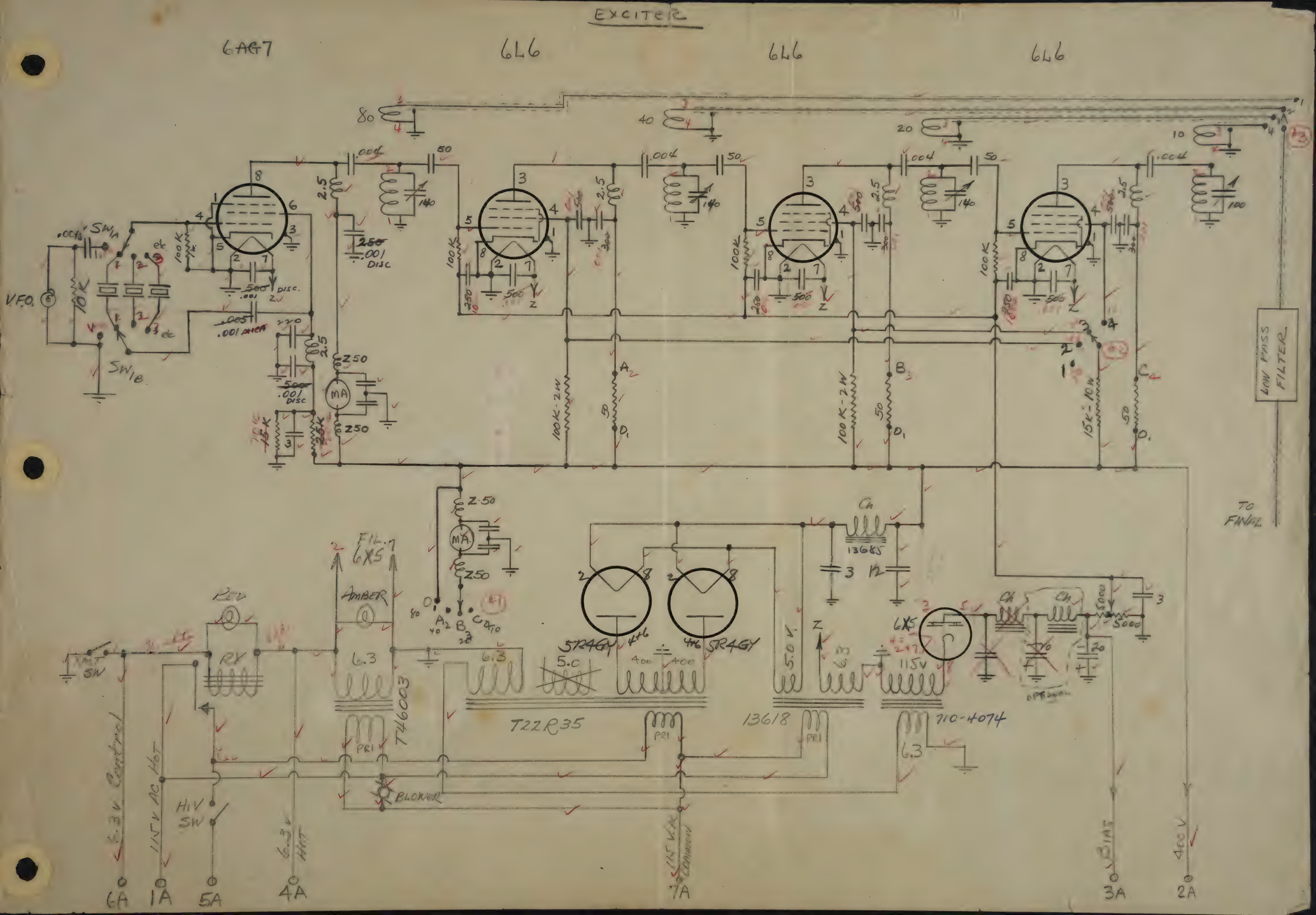
FINAL,

6AG7


8
1
4
5
2
7
.001
SW1A
etc
100K
500
.001
.005
.001 MICA
10K
etc
SW1B


SW
RV
HiV
SW
LH
1A
5A

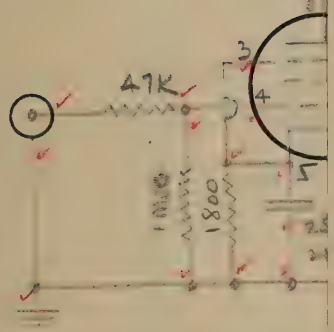
EXCITER


6AG7
6L6
6L6
6L6
80
40
20
10
V.F.O.
SW1A
SW1B
LOW PASS FILTER
TO FINAL
MA
RLY
RX
AMBER
6X5
6.3
T46003
T22R35
13618
710-4074
5T4GY
5R4GY
115V
BLOWER
HIV SW
6.3v Control
115v AC Hot
6.3v Hot
115v AC Common
BIAS
400 V
6A
1A
5A
4A
7A
3A
2A

1 – 3504
3506.8
✓ 2 – 3509
3 – 3513
4 – 3515.2
✓ 5 – 3521.8
6 – 3524.5
✓ 7 – 3528
8 – 3541.7
✓ 9
10 – 3560.7
✓ 11 – 3567.3

✓ – 15.6

MODULATOR



RE-ORDER

A-4763

POLY-PEDANCE DRIV

TRANSFORMER

Capacity 30

Primary Ma. .....120 pe

Ratio Primary to ½ Secondary—

1.25:1, 1.5:1, 1.75:1, 2:1, 2.25:1, 3:

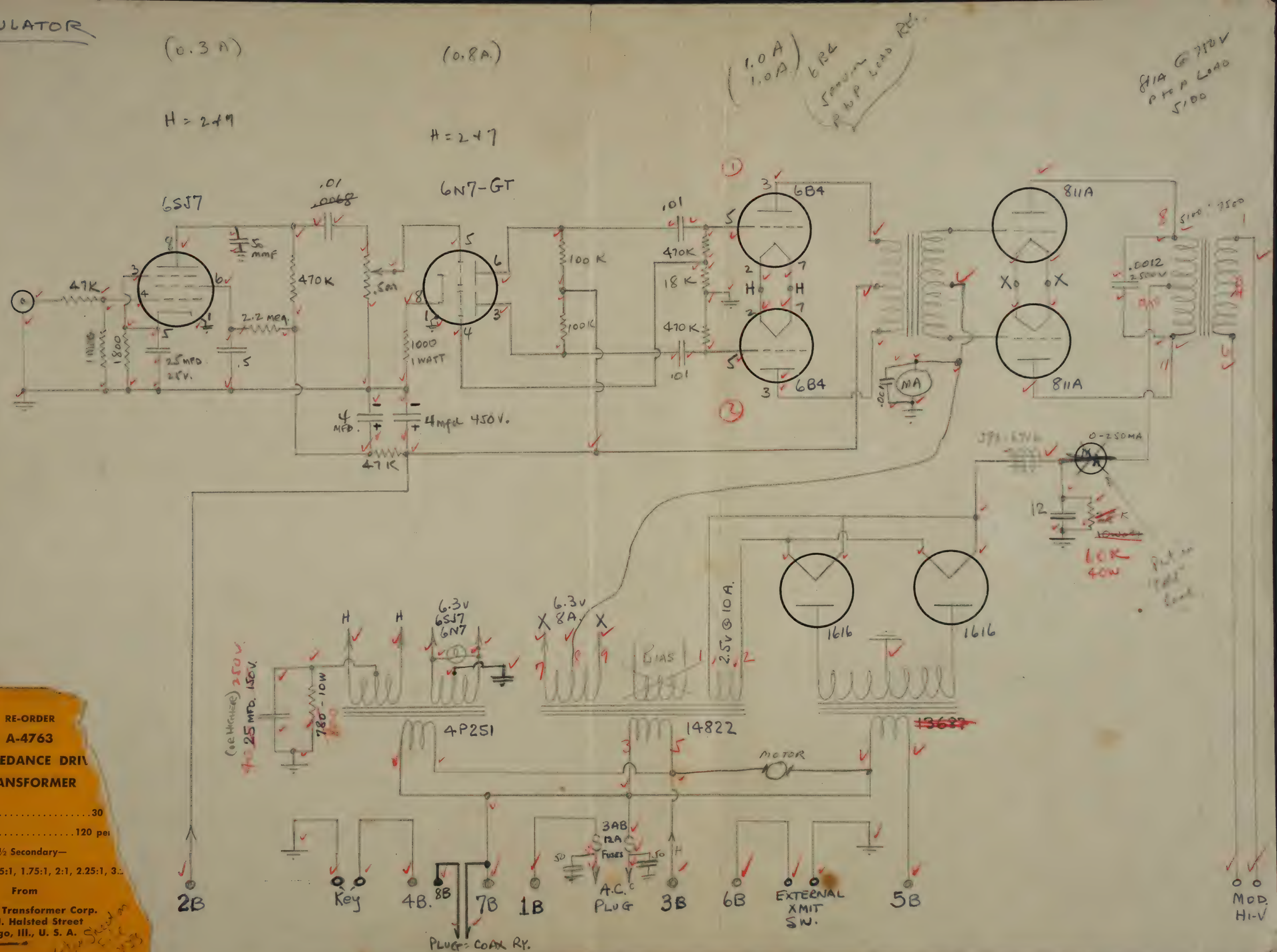
From

Standard Transformer Corp.
1500 N. Halsted Street
Chicago, Ill., U. S. A.

1 – 3504
✓ 2 – 3506.8
3 – 3509
4 – 3513
✓ 5 – 3515.2
6 – 3521.8
✓ 7 – 3524.5
8 – 3528
✓ 9 – 3541.7
10 – 3560.7
✓ 11 – 3567.3

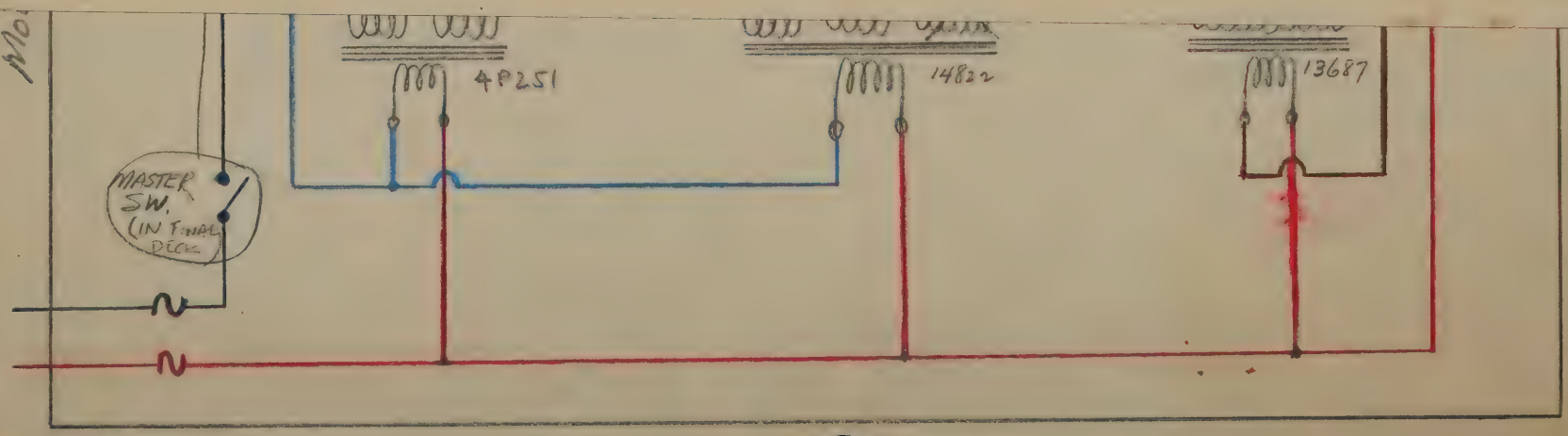
✓ – 11.6m

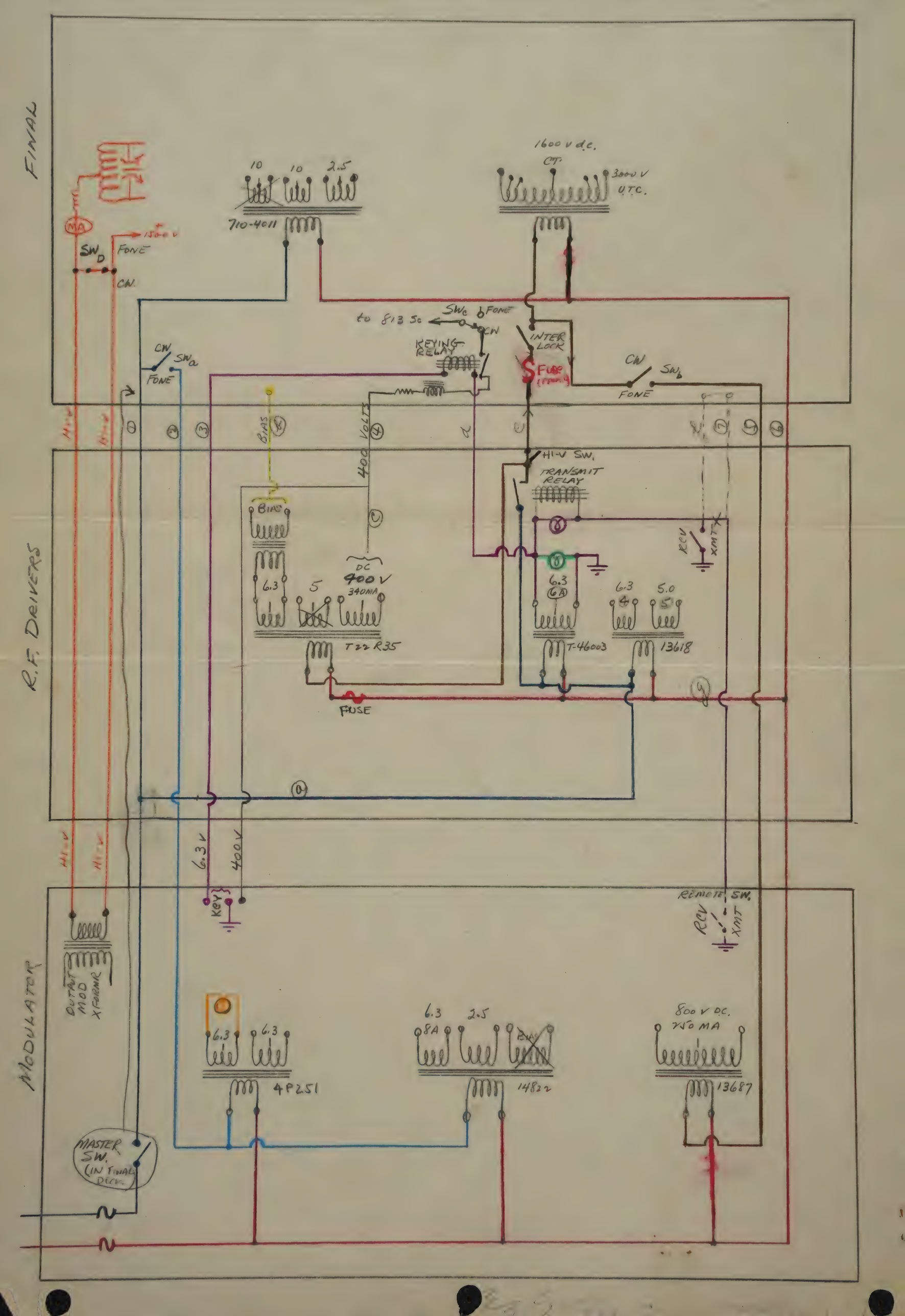
MODULATOR



RE-ORDER
A-4763
POLY-PEDANCE DRIV
TRANSFORMER

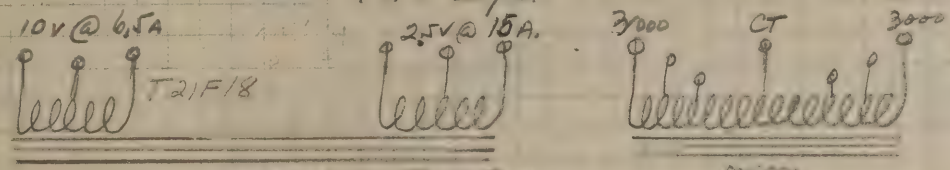
Capacity 30
Primary Ma. .....120 per
Ratio Primary to ½ Secondary—
1.25:1, 1.5:1, 1.75:1, 2:1, 2.25:1, 3:
From
Standard Transformer Corp.
1500 N. Halsted Street
Chicago, Ill., U. S. A.

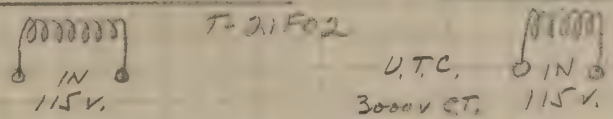

4P251
14822
13687
MASTER SW.
(IN FINAL DECK)


FINAL
R.F. DRIVERS
MODULATOR
MA
SW D
FONE
CW
1500 V
10
10
2.5
710-4011
1600 V d.c.
CT
3000 V
U.T.C.
to 813 Sc
SW c
FONE
CW
KEYING RELAY
INTER LOCK
FUSE
CW
SW b
FONE
CW
SW a
FONE
BIAS
400 VOLT
HI-V SW.
TRANSMIT RELAY
BIAS
6.3
5
DC
400 V
340MA
T22 R35
FUSE
6.3
6A
T-46003
6.3
5.0
13618
REV
XMIT
6.3 V
400 V
KEY
REMOTE SW.
REV
XMIT
OUTPUT MOD XFORMR
6.3
6.3
4P251
6.3
2.5
8A
14822
800 V DC.
750 MA
13687
MASTER SW. (IN FINAL DECK)

FINAL

10 Volts	2.5 volts	Plate 3	Screen 1
C13 @ 5.0 Amps.	866A - 5.0 Amps. 866A - 5.0 Amps. total 10.0 Amps.	1600 v. @ 300 ma.	350 v. @ 40 ma

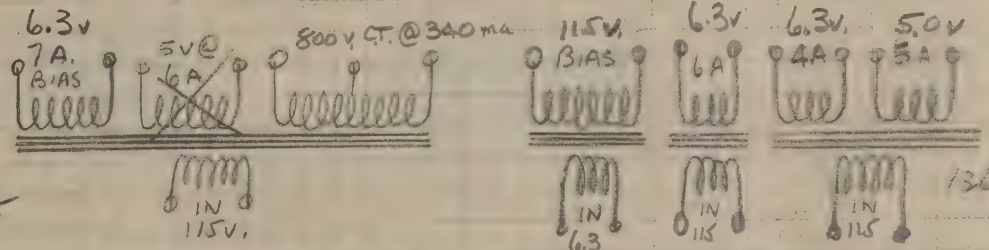




Bias 1
-50v @ 10 ma.

R.F. DRIVERS

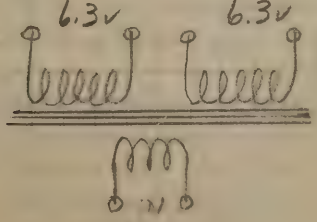
6.3 volts.		5.0 volts		Bias 1	Plate 1
6A67	0.65 Amps.	5R4GY	2.0 Amps.	-50v @ 10 ma	350 v @ 160 ma
6L6	0.90 "	5R4GY	2.0 "		
6L6	0.90 "	total	4.0 Amps.		
6L6	0.90 "				
total	3.35 Amps.				

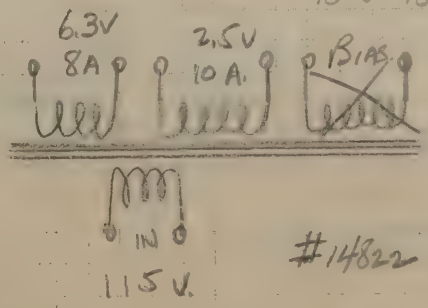


#T-2-R35

MODULATOR

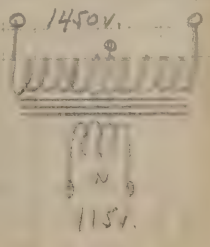
6.3 volts		6.3 volts		6.3 volts		2.5 volts		Plate 1
6SJ7	0.3 Amps.	6B4	1.0 Amp.	811A	4.0 Amps	1616	5.0 Amps.	350 v @ 120 ma
6SJ7	0.3 "	6B4	1.0 "	811A	4.0 "	1616	5.0 "	
6SC7	0.3 "	total	2.0 Amps.	total	8.0 Amps	total	10.0 Amps.	
6N7	0.8 "							
total	1.7 Amps.							





#14822

Plate 2
800 v. @ 250 ma
1450 v.



#1864

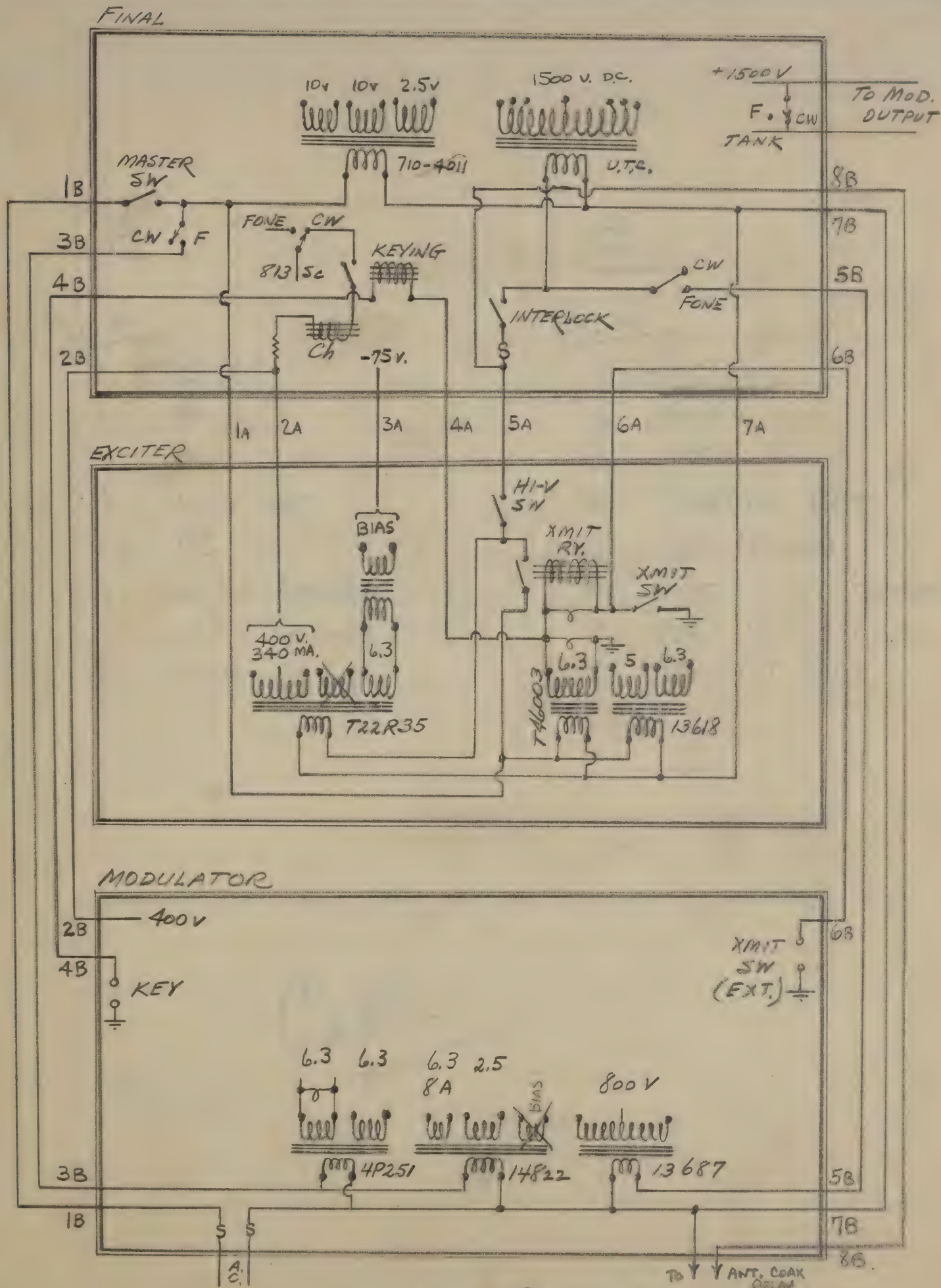


DIAGRAM = POWER CIRCUITS

A

Pin #	
1.	AC Hot
2.	400 v.
3.	BIAS
4.	6.3V HOT
5.	AC. (H-V.)
6.	6.3v CONTROL
7.	115 V. COMMON (F-)
8.	BLANK

B

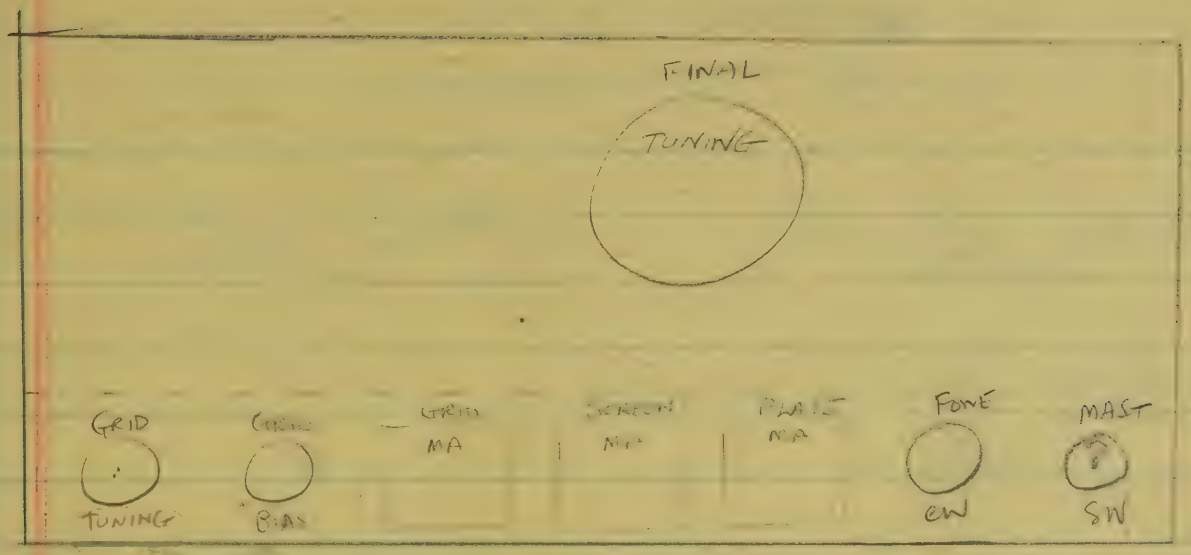
Pin #	
1.	AC HOT
2.	400 v
3.	AC
4.	KEYING CKT
5.	AC (FONE)
6	XMT 6.3V CONTROL
7.	AC 115 V COMMON
8.	AC (ANT SW.)

Cable

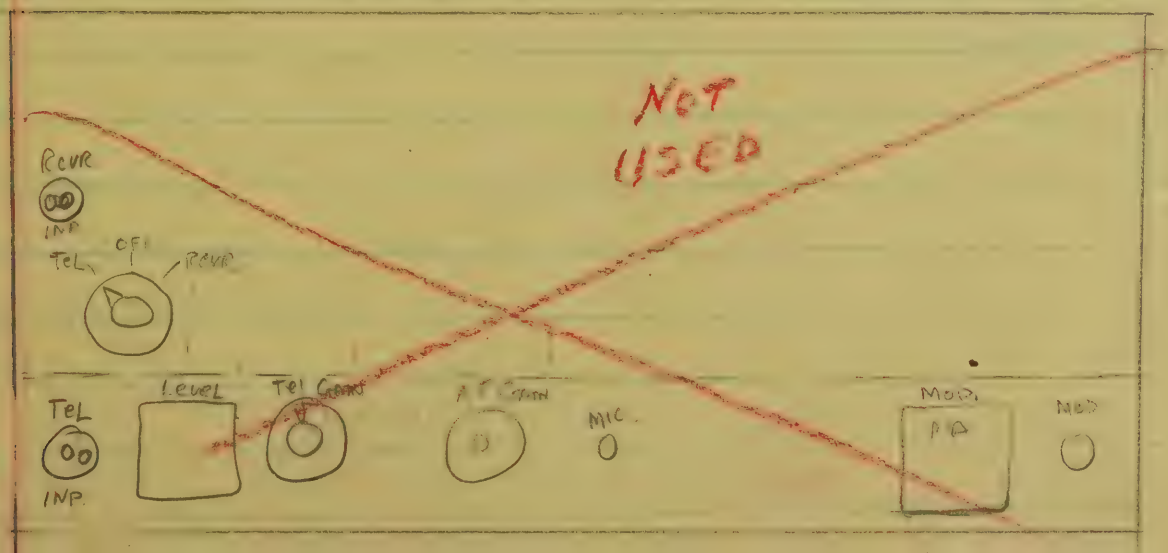
FINAL GRID COILS

		COIL	LINK
1	80	34 TURNS	4 TURNS
2	40	13 "	2 OR 3 "
3	20-15	6 OR 7 "	2
4	10	4 OR 5 "	2

#1


FINAL
TUNING
GRID
TUNING
GRID
BIAS
GRID
MA
PLATE
MA
FONE
CW
MAST
SW

FIL
RF. DRIVER
MA
OSC
MA
XMT
ON
HI-V
OFF
XMT
RCV
BIAS
VOLTAGE
CONTROL
SELECTOR
BAND
20
15
40
10
80
TUNING
10
TUNING
15-20
TUNING
40
TUNING
80
XTL
VFO
VFO


NOT
USED
RCVR
INP
TEL
OFF
RCVR
TEL
INP
LEVEL
TEL GAIN
A.F. GAIN
MIC.
MOD.
PA
MOD

Bias Voltages

Knob Setting	Eg at Control
1	4 volts
2	9.5
3	14.5
4	20.0
5	25.0
6	30.0
7	35
8	40
9	44.5
10	49
11	53
12	56
13	60
14	64

pt # 710-4074

fil. transformer

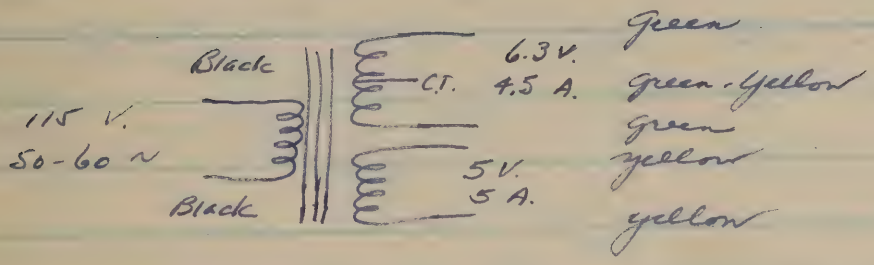
yellow 5V @ 2 AMPS,

6.3V @ 3 AMPS

green red

ORM 116 WORLD WIDE CHICAGO

Filament Transformer — Pt. No. 13618
or 959

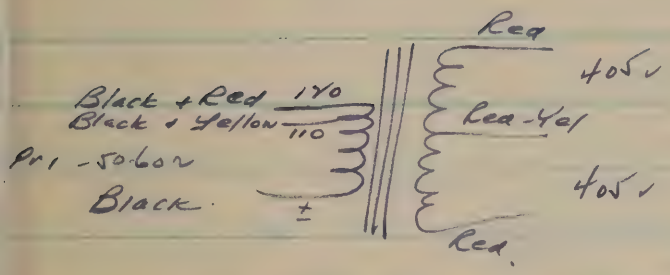


5 v. Secondary is for 83 v tube and has extra high insulation between frame and other windings.

3000 Iron

Plate Transformer

Pt. No. 13617
OP 960-A

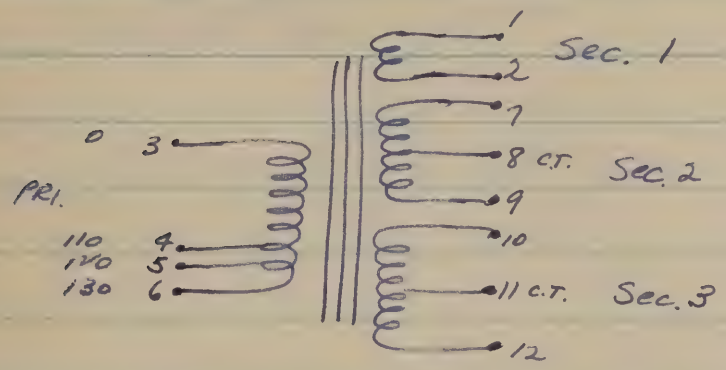


Sec. Rated @ 275 ma.

Will deliver 480 V. dc. with 2 type 83 v Rectifiers and 8 mfd Oil Condenser Input to filter choke

Filament + Bias Transformer

Pt. No. 14822
OP-1045



Primary: 130 V. tapped @ 110 and 120 Volts @ 60 ~

Secondary: #1 - 2.5 V @ 10 Amps.
#2 - 6.3 V @ 8 Amps.
#3 - 75 V. a.c. each side of C.T. to deliver 56 V @ 100 ma. d.c. across 8 mfd.

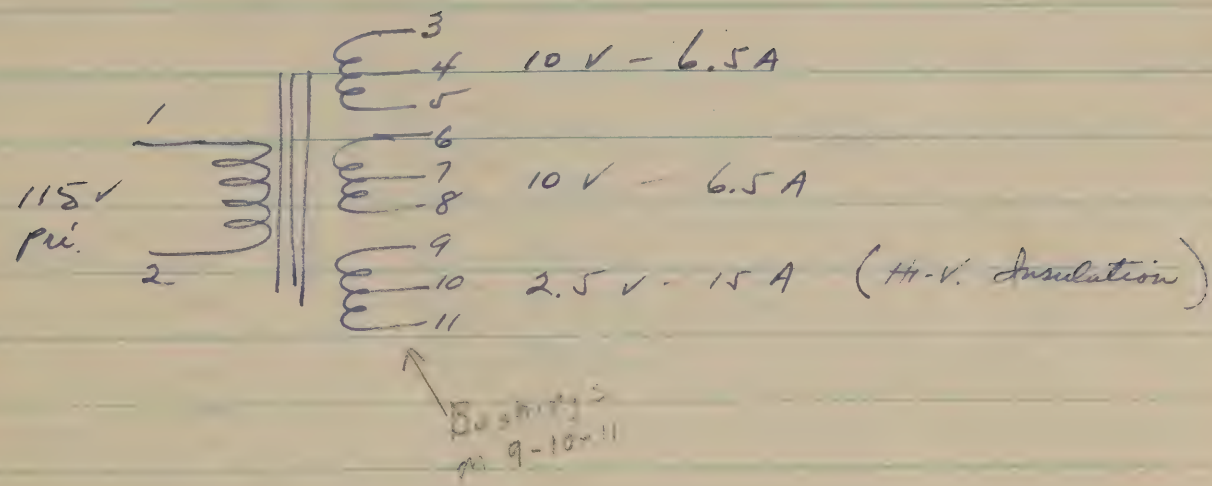
Breakdown Tests - 3000 V. - 60 ~ between windings

Pt. # 593-2

Choke —

10 Hy @ 150 ma

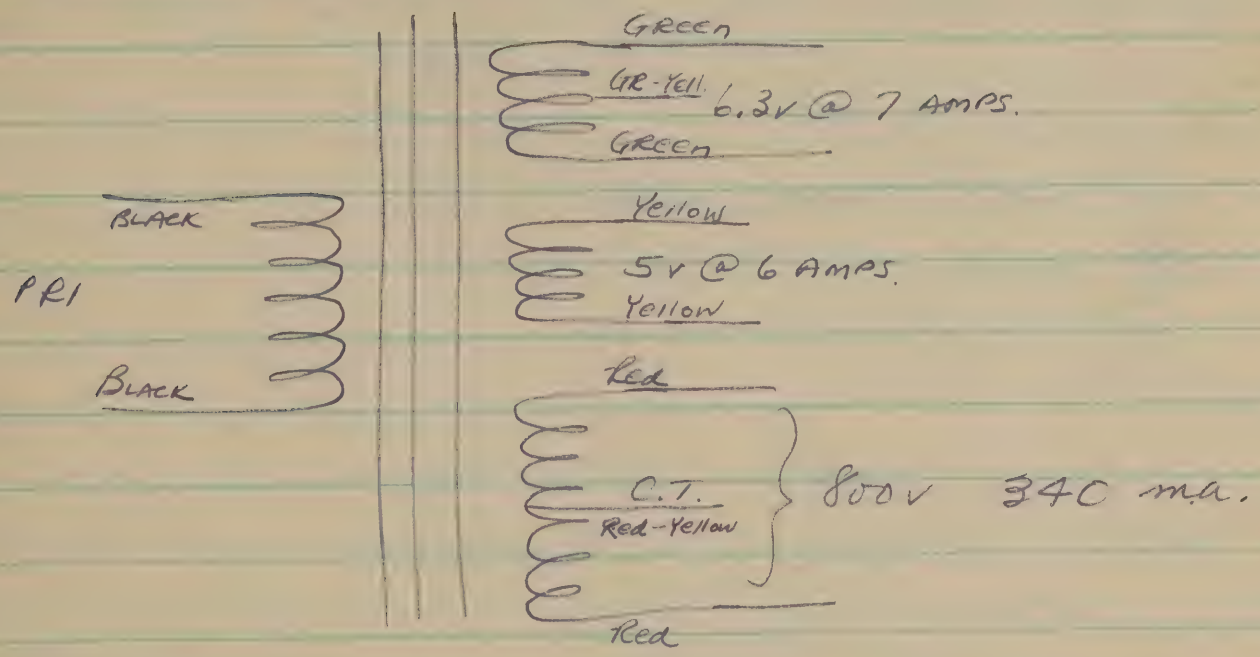
Filament Transformer Pt. No. 710-4011



(1)

Power Transformer — Thordarson # T22R35

Primary 120 v @ 60 cps.



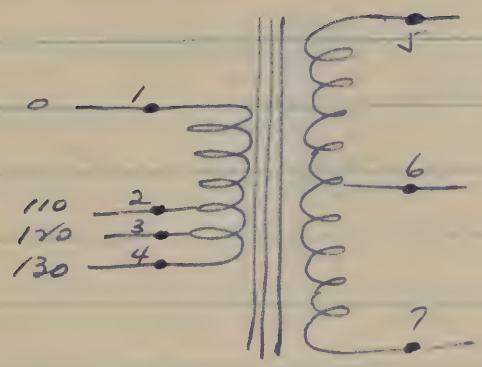
Choke Pt. No. 14688

4.5 ~~H~~ Henry - 80 ma. - 187 ~ dc. Cont
#33 Wire.

135 ma - Intermittent 5 min on
5 min off.

Plate Transformer

Pt. No. 14821
OP-1046



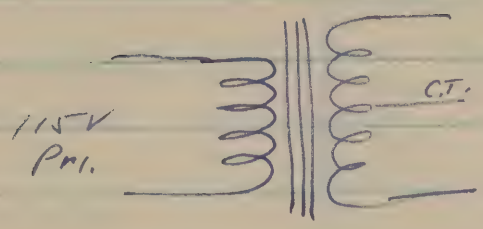
Pri - 130 V. tapped @ 110 + 120 V - 60 ~

Secondary: 725 V ±3% either side
to deliver 635 volts d.c. @ 300 ma.
to choke input filter from 4-866A tubes

Breakdown — 3000 volts.

Filament Transformer

Thordarson - T-46003



6.3 V. @ 6 A.

Available

13687 - 725-0-725 @ 300 ma
(1-20-63)

T-46003 - 6.3 V. @ 6 amps.

UTC - 1500-1250-1000-0-1250-1500 @ 300 ma

710-4011 - 10 V. @ 6.5 A.
(1-20-63)
10 V. @ 6.5 A.
7.5 V @ 15 A.

13686
13[illegible] - 2.5 V @ 10 Amps
6.3 V @ 5.5 Amps.
5.0 V @ 2.0 Amps.
56-0-56 V @ 100 ma. (40 mfd.)

14822 - 2.5 V @ 10 Amps.
6.3 V @ 8 Amps.
75-0-75 @ 100 ma.

T-22R35 - 6.3 V @ 7 amps.
5.0 V @ 6 amps.
400-0-400 @ 340 ma.

13617 405-0-405 @ 275 ma
(3 ans)
(1-20-63)

13618 - 6.3 V @ 4.5 Amps
5.0 V @ 5.0 Amps (Rec-V Ins.)

9804-A - 6.3 V @ 7.5 A.

6716 - Choke 4.5 H. @ 325 ma

14823 - Choke 5.25 H @ 450 ma

13685 Choke 5.0 H @ 500 ma
(1-20-63)

14688 Choke 4.5 H @ 80 ma

13695 choke 4.5 H @ 110 ma
(1-20-63)

13632 output Xfmr 150 W { Push-Pull Parallel
(1-20-63) 4-807 Tubes
Pri. 3900 [illegible]
Sec. [illegible]

1 - (1-20-63)

Power Transformer

Pt. No. 13687
CP - 1070

Pri: 120 v - 60 ~ tapped @ 110 v.
Common - Black.
Tap - Black - Yellow
Finish - Black - Red

Sec: 775 v. a.c. each side of C.T. to supply 300 ma. steady or 500 ma peak d.c. to choke input to an CP 1068 choke with 8 mfd. cond. following and 2 - 866 A rectifiers

Start - Red
CT - Red - Yelle
Finish - Red

Core Iron

Static Shields.

Pt. No. 13672 – OP. 1054

300 v. DC 30 mm [illegible] input

[illegible]

Fil. #1 6.3 v. @ 1.5 Amp

Fil. #2 6.3 v. @ 1.5 Amp

[illegible] 15 v. AC [illegible]

Pt. No. 14687 – OP. 1047 (T-3269) [illegible]

Plate & screen [illegible] 2.5 v. dc.

using 2 – 6L6 [illegible]

[illegible] input

Pt. No. 16475 – OP. 1078

24 v. @ 2.5 Amps filament

transformer

Pt. No. 13675 – OP. 1[illegible] [illegible]

45 hy. [illegible]

Pt. No. 13678 – OP. 1[illegible] [illegible]

40 hy. [illegible]

Pt. 14624 - SP 1-44 Chain
6.6 Fy @ 1[illegible] mm dc
[illegible] dc

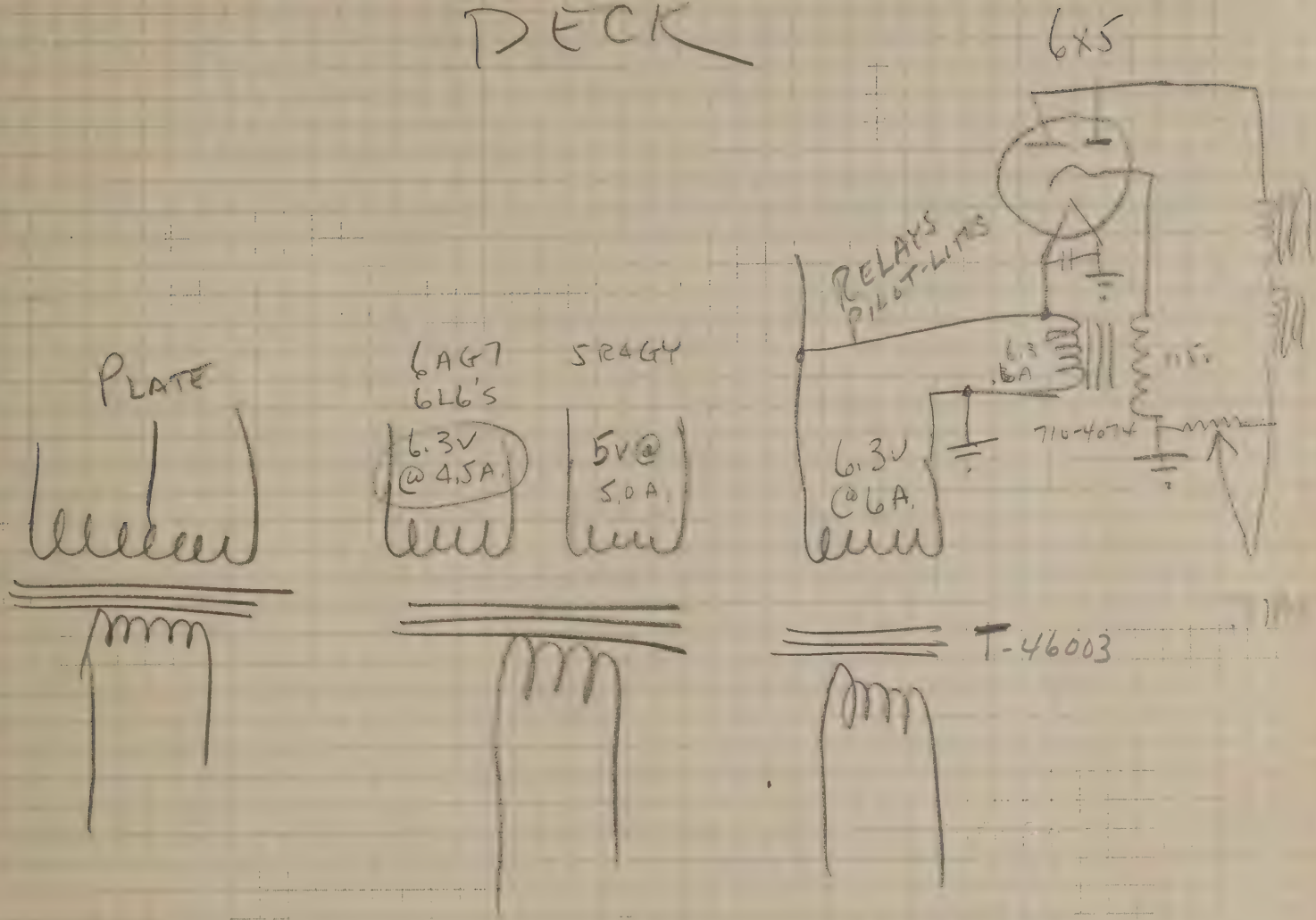
---

14 mm
14658 - SP - 1-44 Chain
7 Fy @ 50 mm [illegible]
125 mm [illegible]
187 Ω dc Res

Panel 2 - Power Supply

✓	1	Terminal Strip
✓	1	A.C. Cord & plugs
	1	Fuse holder and 2 fuses
✓	1	Filament Transformer
✓	1	Plate transformer
✓	2	866A tubes
✓	2	Tube sockets for 866A tubes
	2	Microcondensers for interlocks
✓	2	Pilot lights and [illegible]
✓	1	High Voltage Supply relay (6.3 v. coil)
✓	1	[illegible]
✓	1	High Voltage Switch, [illegible]
?	1	1 mfd 2000 v Oil filled Filter [illegible]
✓	2	Plate caps for 866A tubes
✓	1	Master Key [illegible] switch (Cut-)
	~~4~~	~~500,000 [illegible]~~
✓	2	8 mfd, 1000 v Condensers
	2	50,000 Ω, 50 watt bleeder resistors
✓	1	High voltage [illegible]

EXCITER DECK



p 586
Radio
Handbook

Choke ..... Pt. No. 13685

OP - 1068

5000 Iron

6x Ohms - 5 Henries

to Carry 500 ma.

Filter Choke

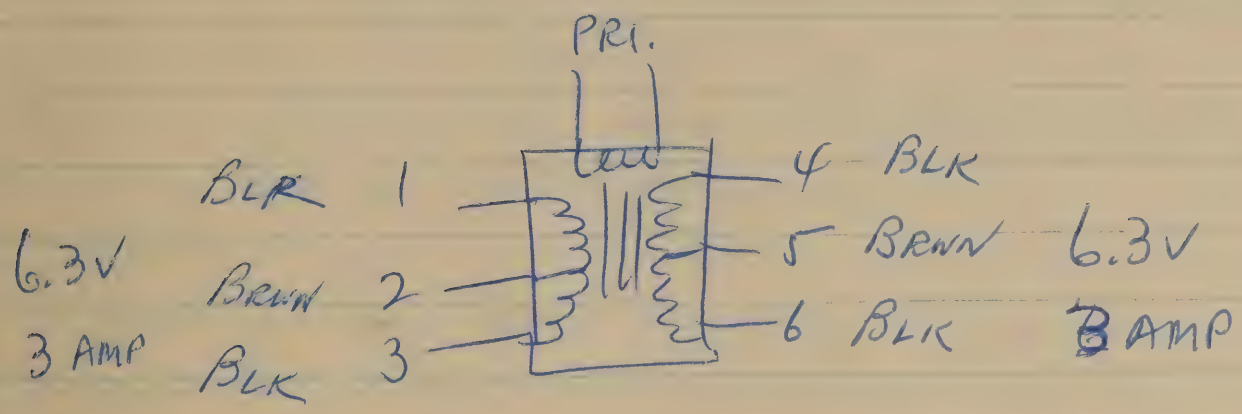
Pt. No. 14823
OP 1017

5.25 henries / .4 A

Pt. No 4P251

Filament Transformer

SNC Co., Oshkosh, Wisc.



(1) (1-27-63)

Output transformer

Pt. No. 13682
OP-1065

150 watt Capacity for
use with four 807 tubes in
push-pull parallel

Pri impedance - 3900 Ohms

Pri: Start - Brown
CT - Red
Finish - Blue
Each half to carry 250 ma. dc.

Sec: With split windings - 500 Ohms total
can be paralleled to reflect 250 -

Winding 1: Outside - Green
Tap - Yellow
Inside - Black

Winding 2: Black-Red on Inside
Tap - Red-Yellow
Outside - Green-Yellow -

Choke

Pt. No. 6716
OP-603

3000 turns to carry 325 ma.
dc. resistance less than 50 Ω.

4 ½ henries

Special Transformers

(1) U.T.C. - 125 watt Universal Modulation Transformer

(1) U.T.C. - Plate Transformer - 1500-1250-1000-0-1000-1250-1500
@ 300 ma.

(1) ~~Thordarson Modulation Transformer - 50 watt~~
~~T-47992~~

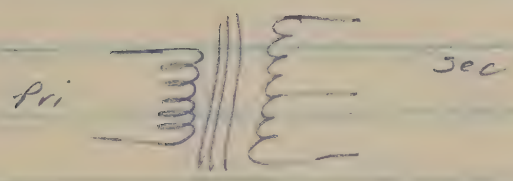
(1) 710-40x14 Power Transformer
5v @ 3 amps
6.3v @ 3.5 amps
740 v c.t. (? ma.)

(1) ~~#543 Electron Power Transformer~~

Smithberg

Driver Transformer Pt. No. 14828

GP - 1042



Pri to total secondary ratio = 1.75:1

for 2 - 6N7 tubes to 4 - 807's

Primary Current 15 ma. dc.

Heater + Fixed Bias transformer

Pt. No 13686
OP 1069

Primary: 120 v @ 60 v, tapped @ 110 v
Common - Black
Tap - Black - Yellow
Finish - Black - Red

Sec. #1: $2\frac{1}{2}$ v @ 10 amps
Start + finish - Yellow

Sec. #2: 6.3 v @ 5.5 amps
Start + finish - Green
C.T. - Green - Yellow

Sec. #3: 56 v a.c. each side of C.T. to supply
44 v d.c. @ 100 ma. to 40 mfd input
condenser from 5V4-G rectifier.
Start + finish - Red
C.T. - Red - Yellow

Sec. #4: 5 v. @ 2.0 amps
Start + finish - Brown
C.T. - Brown - Yellow

Statically shielded.

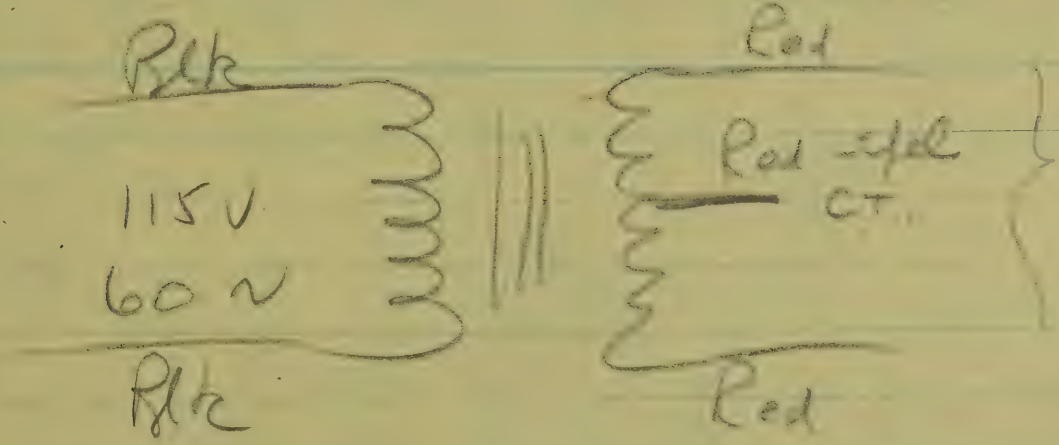
P # P-13-A

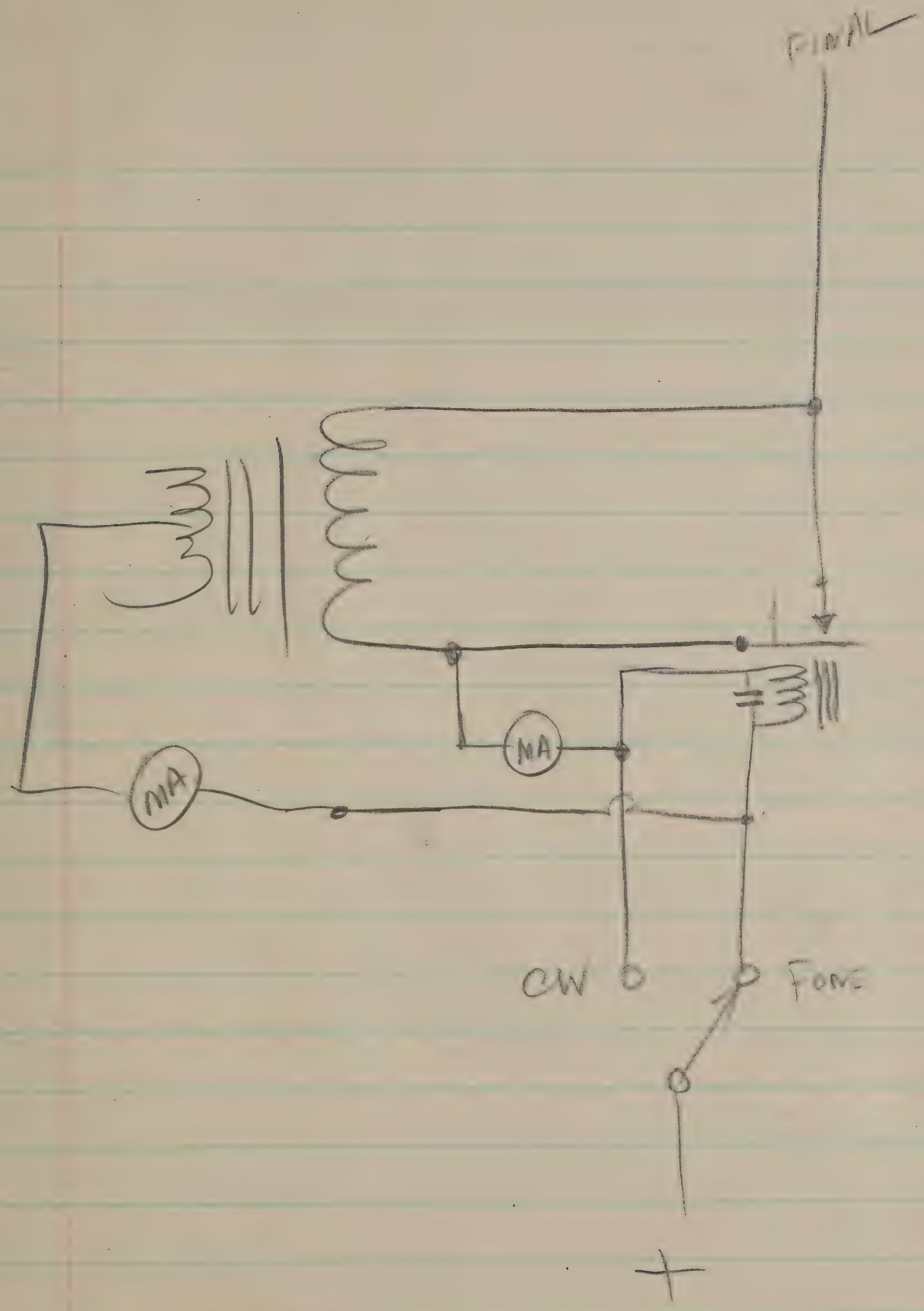
Triad Plate Supply Pwr transformer

1780 V ct

(750 V D.C.)

@ 250 ma. Choke Input




FINAL
MA
MA
CW
FONE
+

FILAMENTS – Panel #1

	@ 6.3 V		@ 5.0 V
6SJ7	– 0.3	5R4GY	– 2.0

FILAMENTS — Panel #1

@ 6.3 v			@ 5.0 v		
6SJ7	-	0.3	5R4GY	-	2.0
6SK7	-	0.6	5R4GY	-	2.0
6H6	-	0.3			4.0
6K7	-	0.8			
807	-	0.9			
807	-	0.9			
807	-	0.9			
807	-	0.9			
		5.6 Amps.			

Tray # 13618

Mon

PLATE TRANSFORMER # ~~14821~~ 13687

FILAMENTS — Panel #2

@ 2.5 v.			@ 10 v.
~~816~~	-	~~2.0~~	
~~816~~	-	~~2.0~~	813 - 5.0 Amps.
		~~4.0~~ Amps.	

PLATE TRANSFORMER # U.T.C.

Pwr Supply

FILAMENTS — Panel #3

@ 6.3 v			@ 5.0 v			
6L6	-	0.9	~~5Z3~~	-	3.0	5U4-G-2
6L6	-	0.9	~~5Z3~~	-	3.0	or 5U4-G-2
6L6	-	0.9			6.0	4.0
6L6	-	0.9				
		3.6 Amps.				

or
RK-22 - 2.5v @ 8.0
3B-23 - 2.5v @ 8.0
pr. 836 - 2.5v @ 10 amp.
pr 1616 - 2.5v @ "

RA

Bias TRANSFORMER: # 14822

PLATE TRANSFORMER: # ~~14821~~ 13617

Summary:
① { 6.3v @ 5.6 amps. — T-46003 - 6.3v @ 6.0 A.
5.0v @ 4.0 "

② { 2.5v @ 4.0 "
10.0 v @ 5.0 " = # 710-4011 { 2.5 v @ 15. A.
10 v @ 6.5 A. also - 10v. @ 6.5 A C.T.

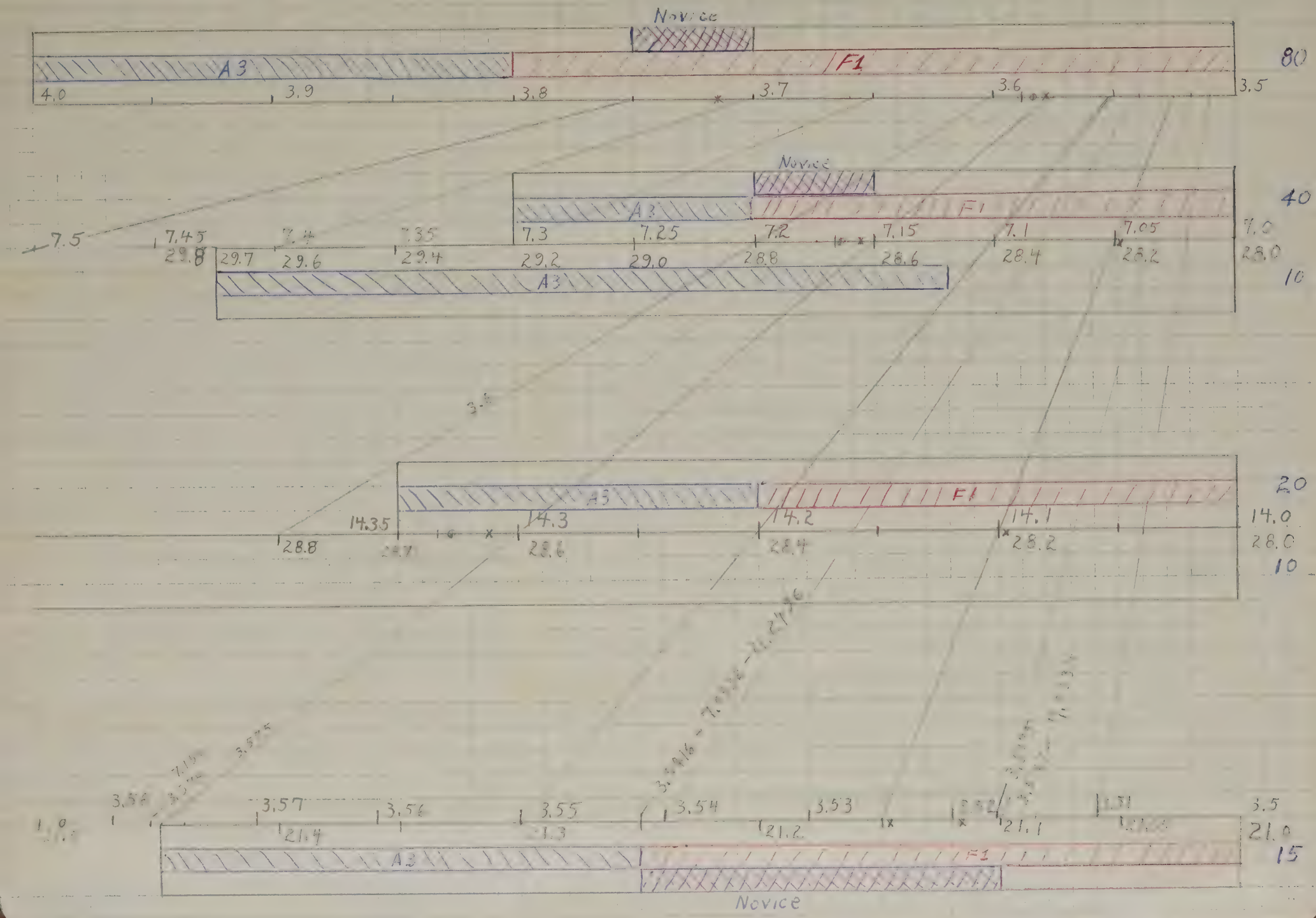
③ { 6.3v @ 3.6 "
5.0 v. @ ~~6.0~~ " (OR 4.0 amps.) = #13618 { 6.3v @ 4.5 A.
5.0 v @ 5.0 A.

Panel 2 - Power Supply

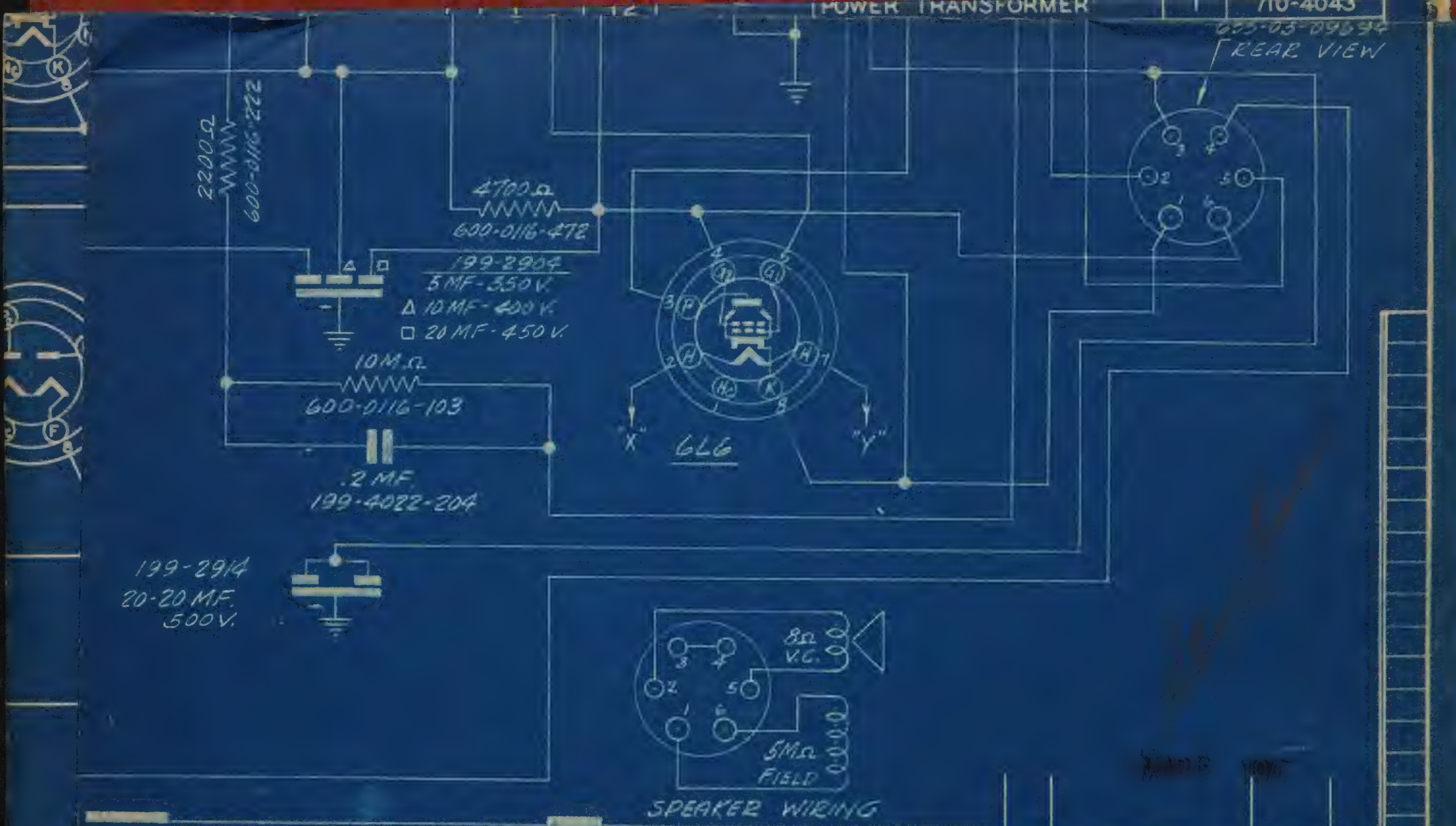
✓	T_1	1500 V. Plate Transformer
✓	(2)	866A Tubes & Sockets.
✓	SW_2	Key locked Switch
✓	CH_1	Choke #13685
✓	SW_1	Plate Switch

Panel 2 - Power Supply

✓ T_1	1500 V. Plate Transformer
✓ (2)	866A Tubes + Sockets.
✓ SW_5	Key locked Switch
✓ CH_1	Choke #13685
✓ SW_1	Plate Switch
SW_2	Interlock Switch
SW_3	Interlock Switch
✓ T_2	Filament Transformer 710-4011
R_{36}, R_{37}	1 Megohm
R_{38}	100,000 Ohms - 100 watt.
✓ Relay,	Plate relay
P_1	Green Jewel + Pilot light
P_2	Red Jewel + Pilot light
✓	Fuses
✓ SW_4	S.P.S.T. Switch
✓ 2	1000 V - 8 mfd Cond.


Novice
A3
F1
4.0
3.9
3.8
3.7
3.6
3.5
80
Novice
A3
F1
7.5
7.45
7.4
7.35
7.3
7.25
7.2
7.15
7.1
7.05
7.0
40
29.8
29.7
29.6
29.4
29.2
29.0
28.8
28.6
28.4
28.2
28.0
10
A3
F1
14.35
14.3
14.2
14.1
14.0
20
28.8
28.6
28.4
28.2
28.0
10
3.57
3.56
3.55
3.54
3.53
3.5
21.4
21.3
21.2
21.1
21.0
15
A3
F1
Novice

1	3522	7044	14088	~~21132~~ 21125	28176
2	3524.7	7049.5	14099	~~21148.5~~ 21173	28198
3	3528	7056	14112	21168	28224
4	3532.5	7065	14130	21185	28260
5	3537	7074	14148	21222	28296
6	3541.7	7083.4	14166.8	21256.2	28333.6
7	3572	7142	14284	21426	28568
8	35780	7156	14312	21568	28624
9	3582	7164	14328	21492	28656
10	3968	7936	14872	22808	29744
11	3502	7004	14008	21012	28016



UNLESS OTHERWISE SPECIFIED DECIMAL DIMENSIONS TO BE ±. FRACTIONAL DIMENSIONS TO BE ±

ISSUE	WAS	DATE	APPR.

OPERADIO
OPERADIO MANUFACTURING CO.
ST. CHARLES, ILL., U.S.A.

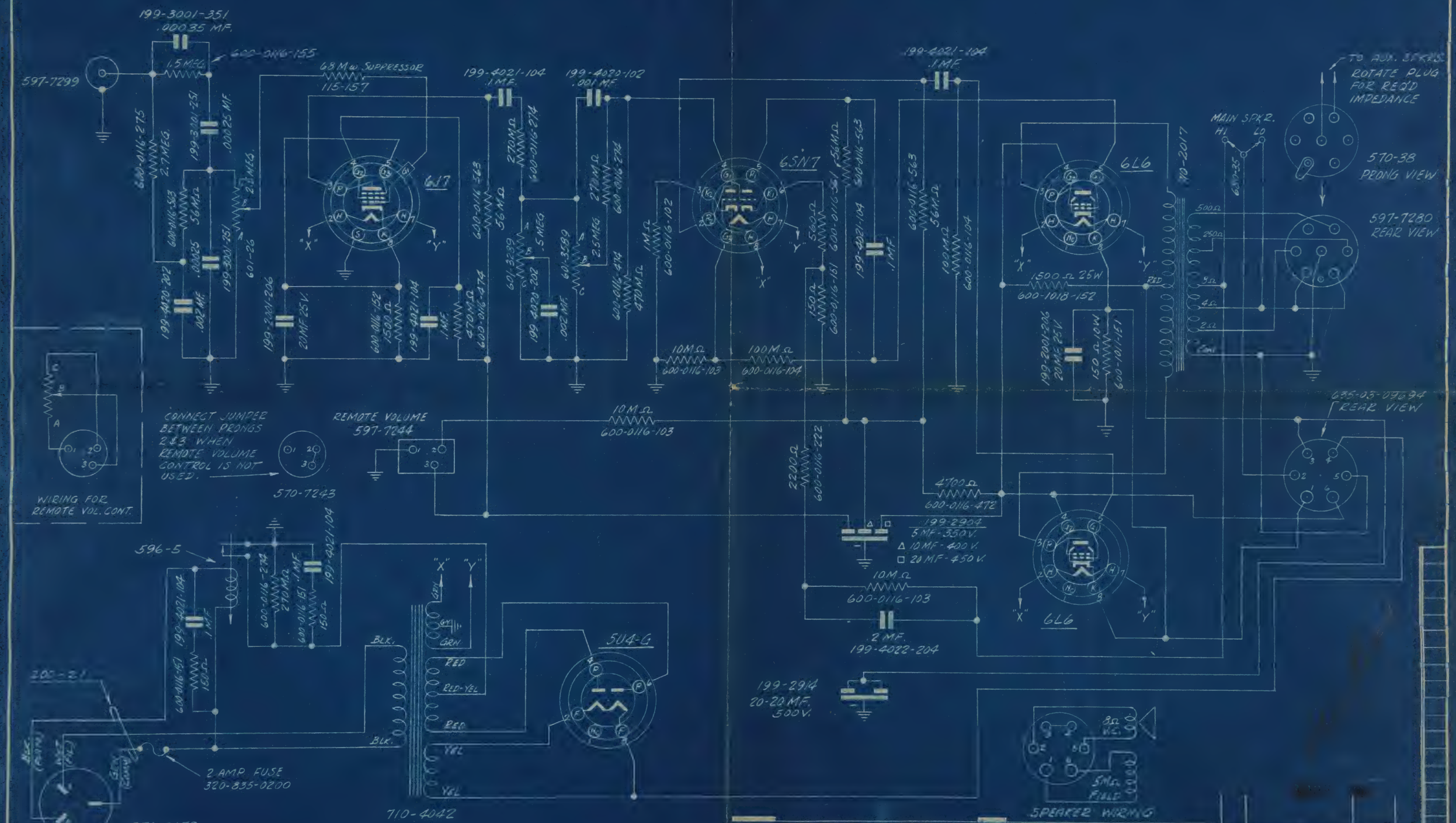
CIRCUIT DIAGRAM
MOD. PIA75
(MP 718)

SCALE		DATE 11-25-46
DRAWN AAP	APP'D	NO. 190-106
CHECKED	ENGR.	

ISSUE 00

190-106

REQ. REQ'S	USED ON



UNLESS OTHERWISE SPECIFIED DECIMAL DIMENSIONS TO BE ± . FRACTIONAL DIMENSIONS TO BE ± "

ISSUE	WAS	DATE	APPR.

OPERADIO
OPERADIO MANUFACTURING CO.
ST. CHARLES, ILL., U.S.A.

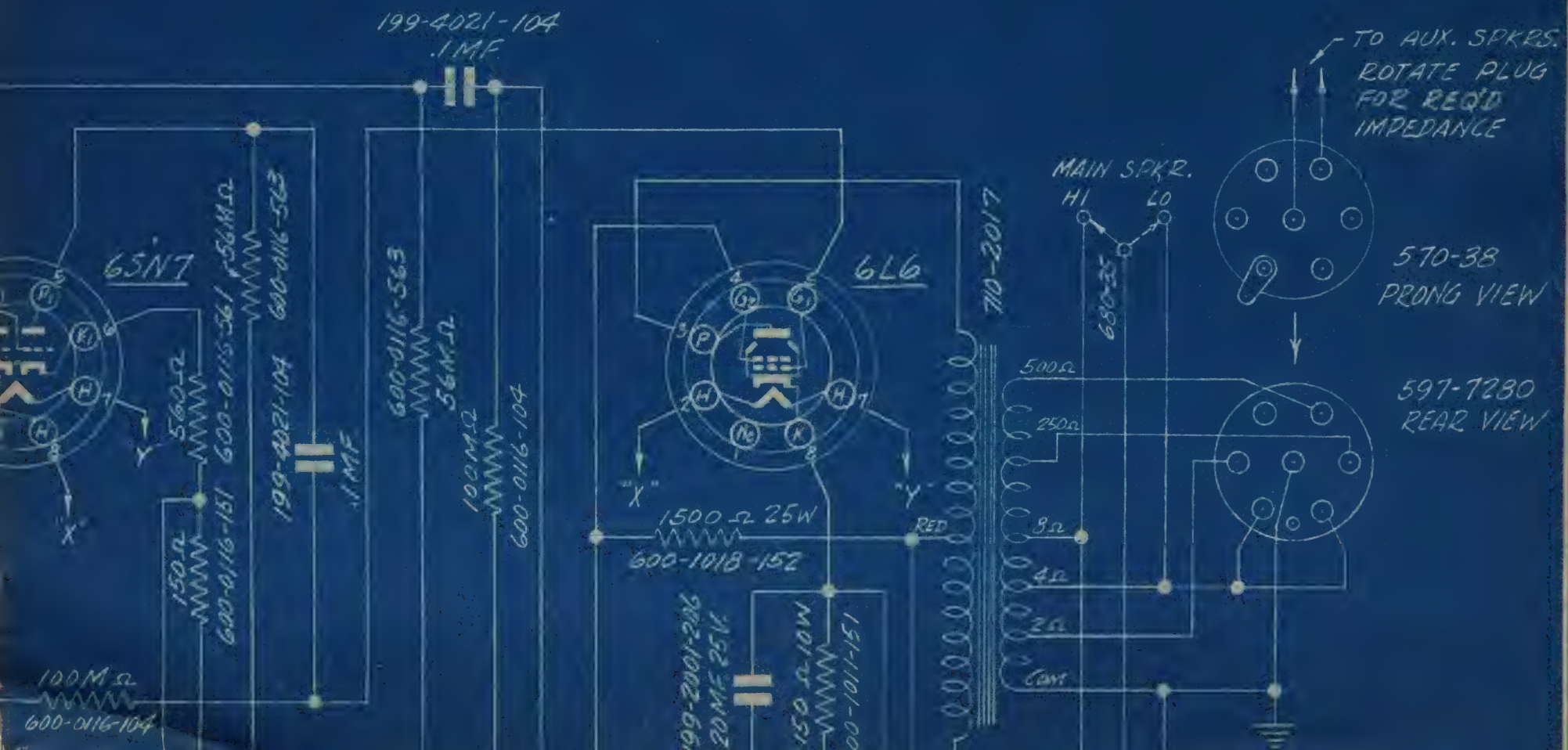
CIRCUIT DIAGRAM
MOD. P1A75
(MP 718)

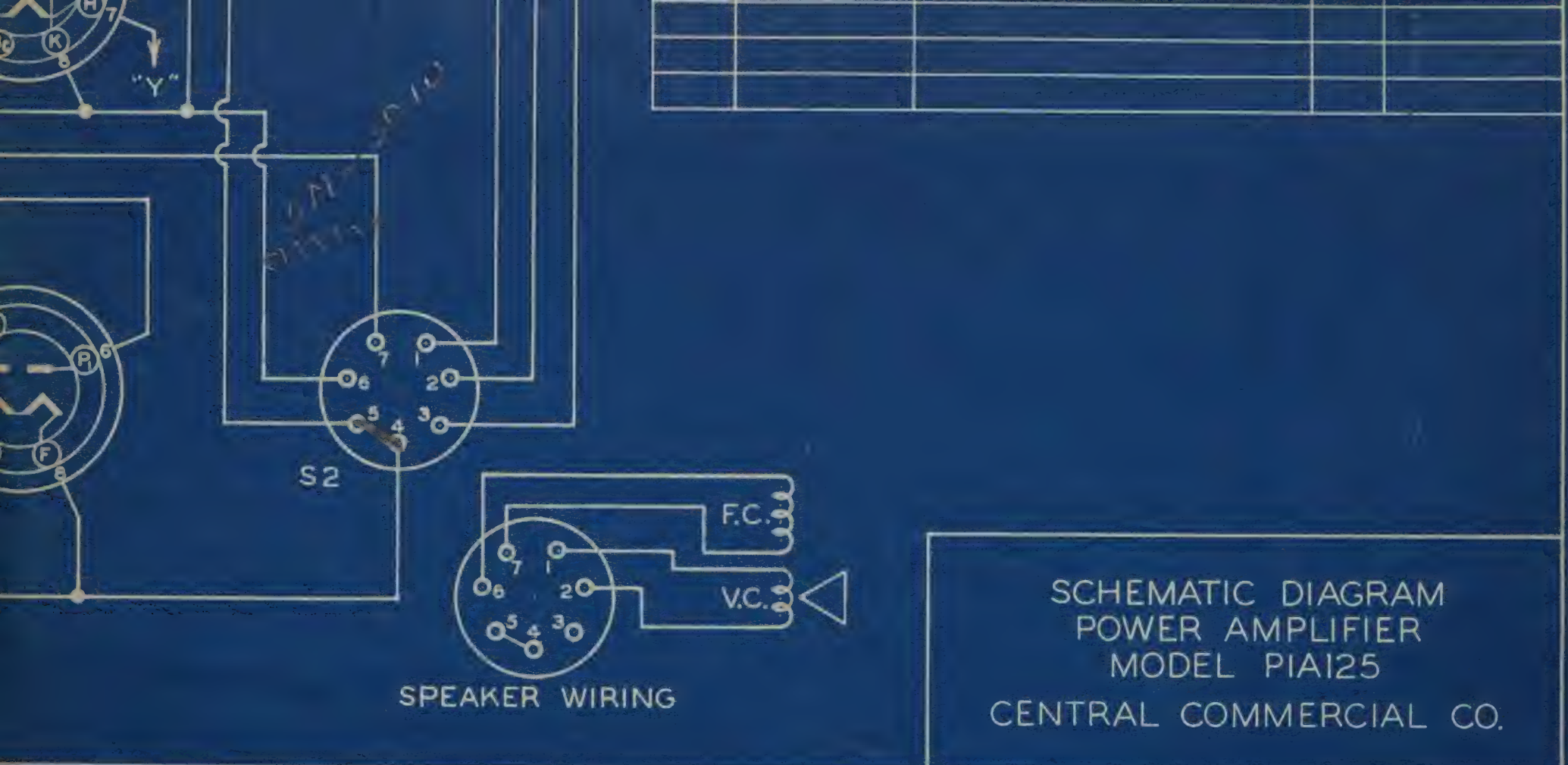
SCALE		DATE 11-25-46	
DRAWN AAP	APP'D	NO. 190-106	
CHECKED	ENGR.		

ISSUE 00

190-106

NO. REQ'D	USED ON





01	REVISED - REDRAWN	5-28-47		
ISSUE	WAS	DATE	APPR	

MATERIAL _____ FINISH _____

UNLESS OTHERWISE SPECIFIED DECIMAL DIMENSIONS TO BE ± ' FRACTIONAL DIMENSIONS TO BE ± '

OPERADIO

OPERADIO MANUFACTURING CO.
ST. CHARLES, ILL., U. S. A.

SCHEMATIC DIAGRAM
MODEL PIA125

SCALE –

DATE 10 - 10 - 46

DRAWN Burch

APP'D AK

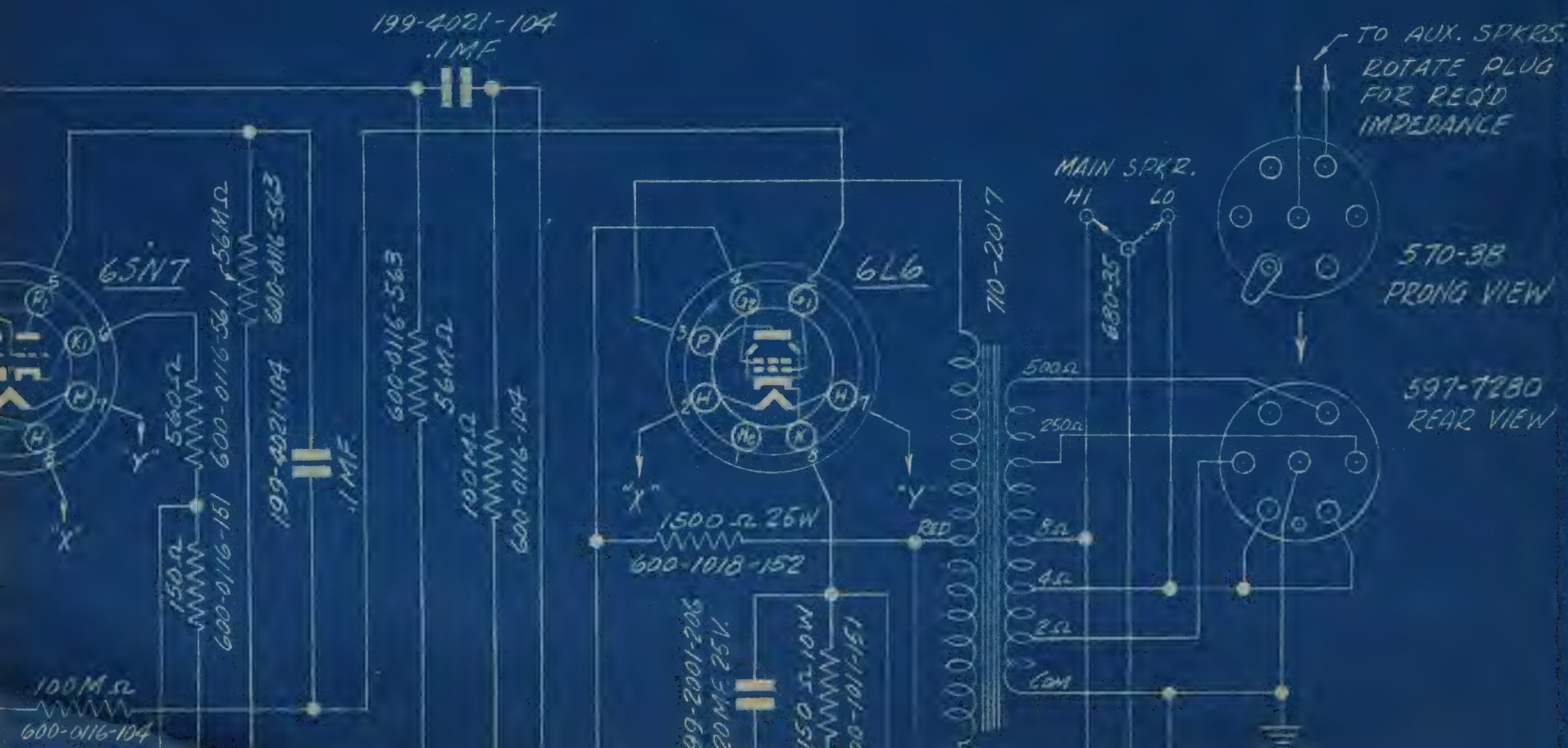
CHECKED

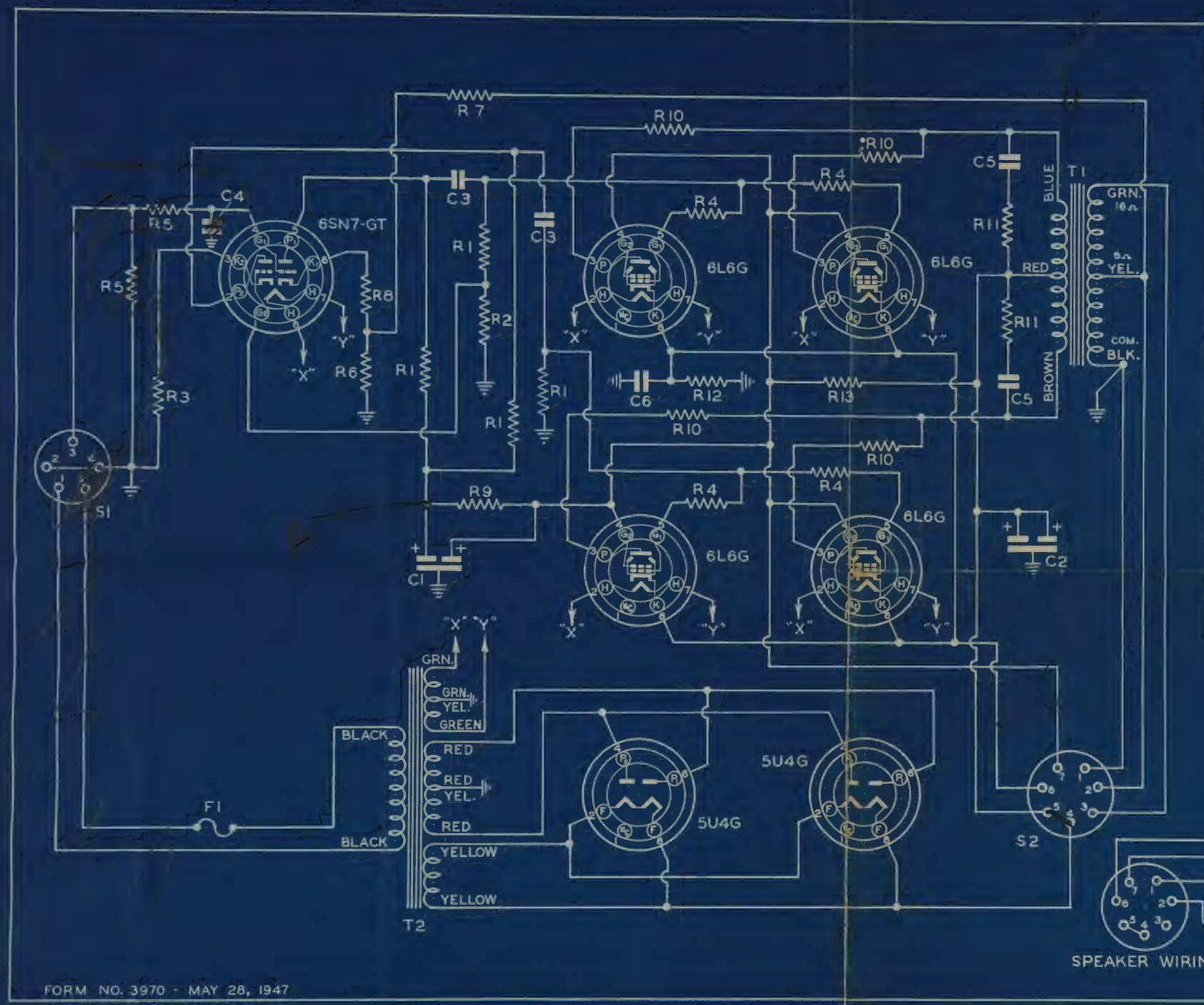
ENGR

190-103

190-106

NO. REQ'D	USED ON





LIST OF ELECTRICAL PARTS

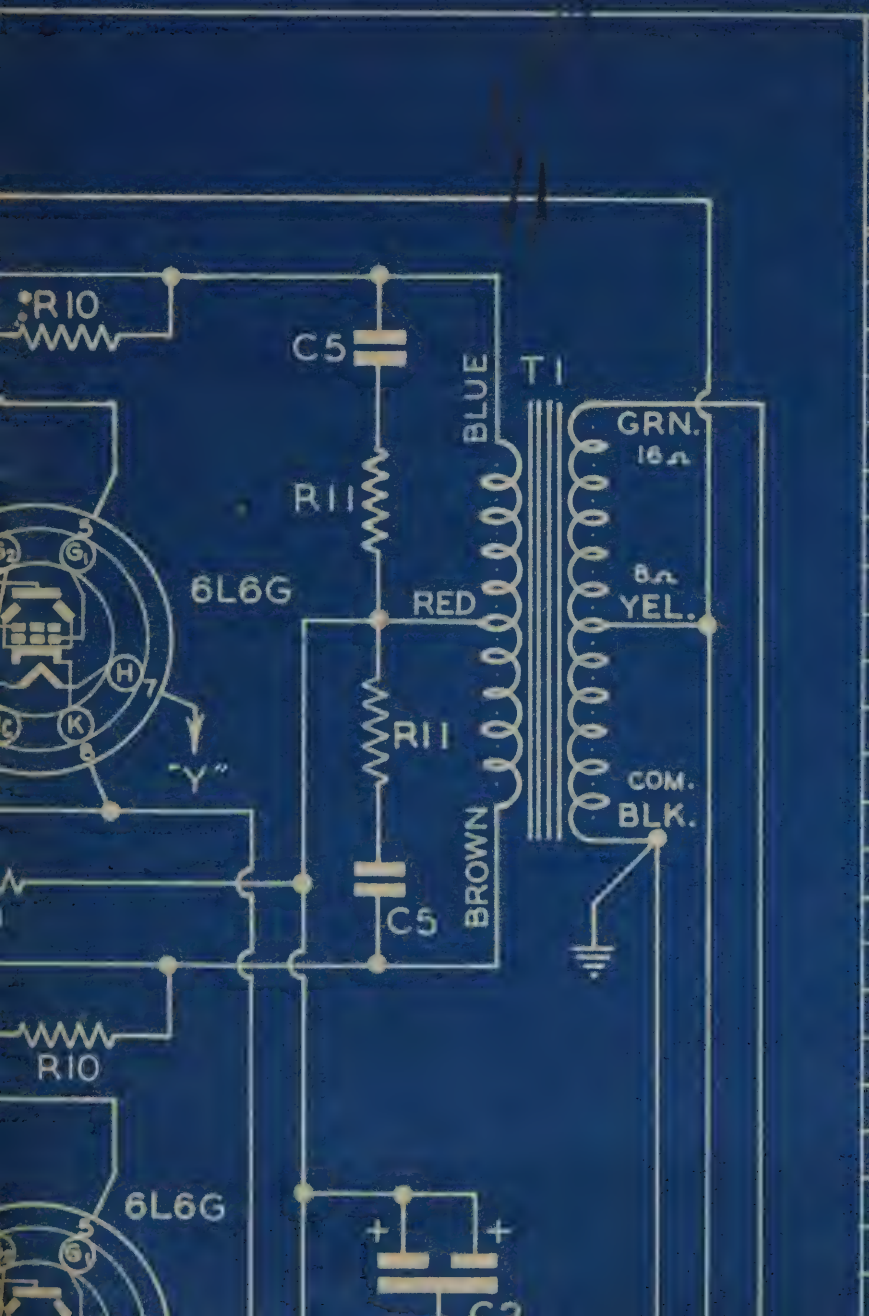
QUANTITIES ARE FOR ONE AMPLIFIER

LEGEND	C.C. PART NO.	DESCRIPTION	NO. REQ'D.	STOCK NO.
C1		CAPACITOR 10-10 MFD. 450 V.	1	199-2902
C2		CAPACITOR 20-20 MFD. 500 V.	1	199-2914
C3		CAPACITOR .5 MFD. 400 V.	2	199-4022-504
C4		CAPACITOR .00025 MFD. 600 V.	1	199-4030-251
C5		CAPACITOR .002 MFD. 1000 V.	2	199-5041-202
C6		CAPACITOR 100 MFD. 50 V.	1	199-2008-107
F1		FUSE 3 AMP.	1	320-835-0300
R1		RESISTOR 47,000 OHMS 1 W.	4	600-0110-473
R2		RESISTOR 5600 OHMS 1 W.	1	600-0110-562
R3		RESISTOR 1000 OHMS 1 W.	1	600-0116-102
R4		RESISTOR 10,000 OHMS 1 W.	4	600-0116-103
R5		RESISTOR 100,000 OHMS 1 W.	2	600-0116-104
R6		RESISTOR 150 OHMS 1 W.	1	600-0116-151
R7		RESISTOR 1500 OHMS 1 W.	1	600-0116-152
R8		RESISTOR 560 OHMS 1 W.	1	600-0116-561
R9		RESISTOR 4700 OHMS 2 W.	1	600-0153-472
R10		RESISTOR 50 OHMS 5 W.	4	600-1008-500
R11		RESISTOR 5000 OHMS 10 W.	2	600-1011-502
R12		RESISTOR 100 OHMS 25 W.	1	600-1018-101
R13		RESISTOR 1200 OHMS 25 W.	1	600-9008
S1		PLUG 5 CONTACT	1	597-35
S2		SOCKET "SPEAKER"	1	635-03-09623
T1		OUTPUT TRANSFORMER	1	710-2021
T2		POWER TRANSFORMER	1	710-4043

SCHEMATIC DIAGRAM
POWER AMPLIFIER
MODEL PIA125
CENTRAL COMMERCIAL CO.

FORM NO. 3970 - MAY 28, 1947

MATERIAL	FINISH	01	REVISED - REDRAWN 5-28-47
UNLESS OTHERWISE SPECIFIED DECIMAL DIMENSIONS TO BE ± FRACTIONAL DIMENSIONS TO BE ±		ISSUE	WAS / DATE / APPR.
OPERADIO — OPERADIO MANUFACTURING CO. ST. CHARLES, ILL. U.S.A.	SCHEMATIC DIAGRAM MODEL PIA125	SCALE — / DATE 10-10-46	01
		DRAWN / APP'D / CHECKED / ENGR	No. 190-103



LIST OF ELECTRICAL PARTS

QUANTITIES ARE FOR ONE AMPLIFIER

LEGEND	C.C. PART NO.	DESCRIPTION	NO. REQ'D.	STOCK NO.
C1		CAPACITOR 10-10 MFD. 450 V.	1	199-2902
C2		CAPACITOR 20-20 MFD. 500 V.	1	199-2914
C3		CAPACITOR .5 MFD. 400 V.	2	199-4022-504
C4		CAPACITOR .00025 MFD. 600 V.	1	199-4030-251
C5		CAPACITOR .002 MFD. 1000 V.	2	199-5041-202
C6		CAPACITOR 100 MFD. 50 V.	1	199-2008-107
F1		FUSE 3 AMP.	1	320-835-0300
R1		RESISTOR 47,000 OHMS 1 W.	4	600-0110-473
R2		RESISTOR 5600 OHMS 1 W.	1	600-0110-562
R3		RESISTOR 1000 OHMS 1 W.	1	600-0116-102
R4		RESISTOR 10,000 OHMS 1 W.	4	600-0116-103
R5		RESISTOR 100,000 OHMS 1 W.	2	600-0116-104
R6		RESISTOR 150 OHMS 1 W.	1	600-0116-151
R7		RESISTOR 1500 OHMS 1 W.	1	600-0116-152
R8		RESISTOR 560 OHMS 1 W.	1	600-0116-561
R9		RESISTOR 4700 OHMS 2 W.	1	600-0153-472
R10		RESISTOR 50 OHMS 5 W.	4	600-1008-500
R11		RESISTOR 5000 OHMS 10 W.	2	600-1011-502
R12		RESISTOR 100 OHMS 25 W.	1	600-1018-101
R13		RESISTOR 1200 OHMS 25 W.	1	600-9008
S1		PLUG 5 CONTACT	1	597-35
S2		SOCKET "SPEAKER"	1	635-03-09623
T1		OUTPUT TRANSFORMER	1	710-2021

	10	20	40	80
1	28070	14035	7018	3509
2	28106	14053	7026.6	3513.3
3	28122	14061	7030.5	3515.2
4	28150	14075	7037.6	3518.8
5	28176	14088	7044	3522
6	28198	14099	7049.5	3524.7
7	28224	14112	7056	3528
8	28260	14130	7065	3532.5
9	28296	14148	7074	3537

3500
3505
3510
3515
3520
3525
3530
3535
3540
3545
3550

CM XTALS

10	28000	15	21000	20	14000	25	7000	30	3500
	28072		21054		14036		7018		3509
	28104				14052		7026		3513
	28154.4		21115.8		14077.2		7038.6		3519.3
	28196		21147		14098		7049		3524.5
					14200				
	28440		21330		14220		7110		3555
	28476.4		21357.3		14238.2		7119.1		3559.55
28485.4	28500		21364.2		14242.8		7121.4		3560.70
	28572		21429		14286		7143		3571.5
			21450		14300				
	28744				14372		7186		3593
					14400				
							7300		

END= 29,700

END= 4000

	Freq.	Grid Coil	Grid Dial	Tank Coil	Tank Dial
	19.4	10-15M		10 M	100
	19.7	10+			90
	20.6		9.3		80
	21.0		8.9		75.7
	.1		8.8		74.6
15	.2		8.7		73.4
	.3		.6		72.6
	.4		.6		71.4
	.5		.4		70.3
	22.5		7.5		60
	23.5		6.8		50
	24.8		5.9		40
	26.3		5.0		30
	27.0		4.8		26.2
	28.		4.2		21.5
	28.5		4.0		19.4
	.6		4.		19.0
10	.7		4		18.6
	.9		3.9		17.7
	29.1		3.9		16.9
	31		3.2		10
	33		2.8		0.0
	36.2		2.0		
	38.5		1.0		

	Freq.	Grid Coil	Grid Dial	Tank Coil	Tank Dial
	13.3	15-20M	10	15-20M	[redacted]
	13.5		10		100
	13.7		9		92
	13.9		8.8		88.2
	14.0		8.6		86.4
20	14.1		8.4		84.6
	14.2		8.3		82.8
	14.3		8.1		81.0
	14.4		8.0		79.4
	14.5		7.9		77.8
	14.9		7.2		70
	15.7		6.5		60
	16.4		5.9		50
	17.3		5.0		40
	18.4		4.4		30
	19.7		3.6		20
	20.9		3.0		~~10.3~~ 13.4
	21.0		3		12.8
	21.1		3		12.3
15	.2		3		11.8
	.3		3		11.2
	.4		2.9		10.7
	.5		2.9		10.2
	22.5		2.5		5.0
	23.1		2.3		0.0
	26.5		1.0		—

Freq.	Grid Coil	Grid Dial	Tank Coil	Tank Dial
6.02	40M		40M	100
6.25				90
6.5				80
6.75				70
6.95		10.0		64.5
7.0		9.7		62.9
7.1		9.3		59.4
40 7.2		9.0		56.4
7.3		8.7		52.0
7.4		8.3		50.5
7.5		8.1		47.7
7.9		7		37.2
8.5		6		26.1
9.0		5		18.5
9.8		4		09.1
11.0 10.3		3		01.8
12.6		2		
13.7		1		

Tuning Data MHB Xmtr.

Grid Coil	Dial	Freq.		Tank Coil	Dial
80 M	10	3.05	3319	80M – 1534	
(A)	7.5	3.4		3.42	100
	7.0	3.5		3.5	87.3
	6.6	3.6	100.0	3.6	80.3
	5.7	3.8	80.2	3.8	67.6
	5.3	3.9	73.5	3.9	61.7
	5.0	4.0	68.6	4.0	55.6
	4.8	4.1		4.1	50.3
	4.0	4.3		4.3	40.0
	3.0	4.8		4.8	24.1
	2.0	5.4+		5.3	14
	1.0	6.0		5.5	12
80M	10	3.02		5.8	0
(B)	8.5	3.4			
	8.0	3.5			
	7.5	3.6			
	6.5	3.8			
	6.0	3.9			
	5.8	4.0			
	5.3	4.1			

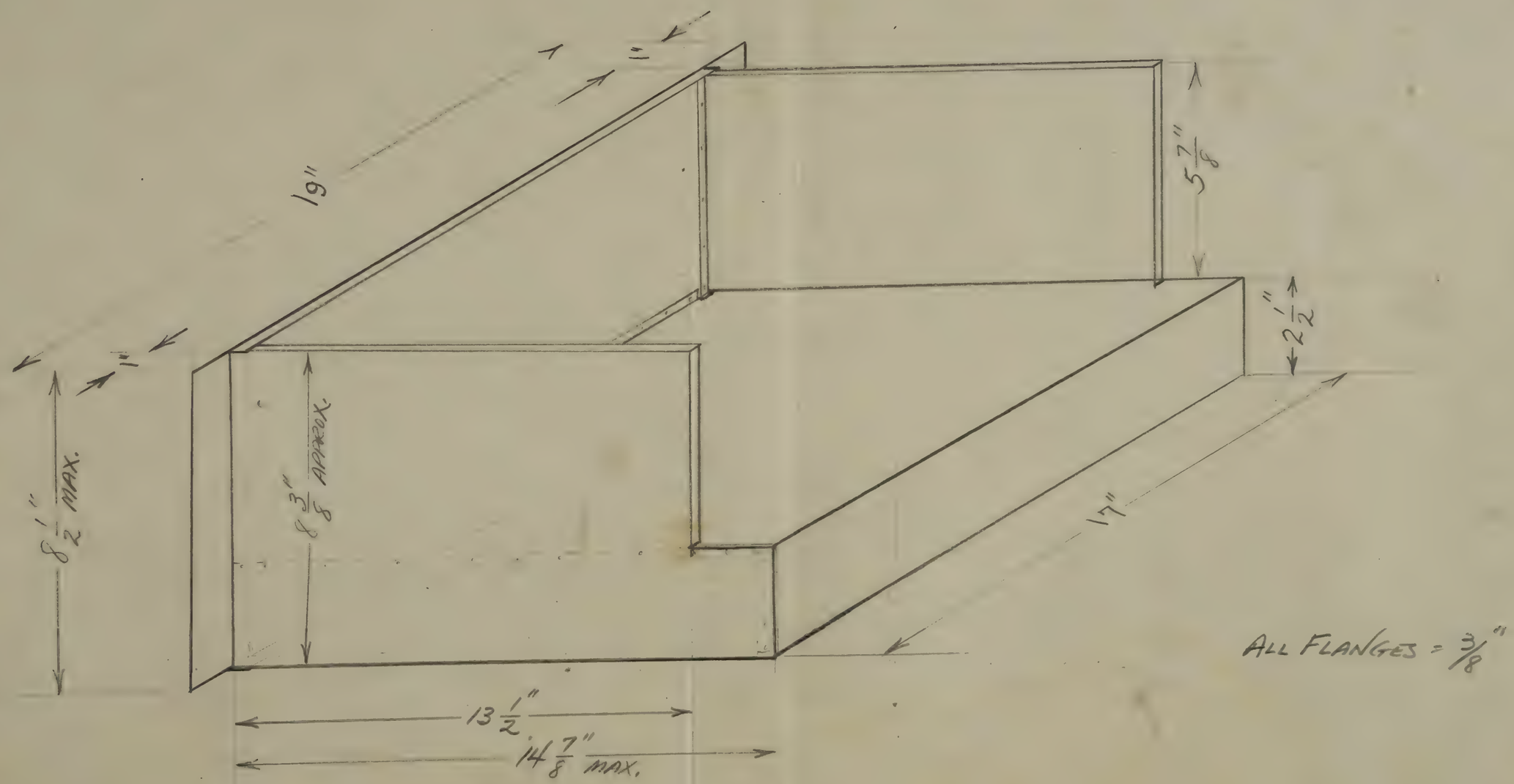
6.02	100
6.25	90
6.5	80
	70.0
6.75	~~6.75~~

Grid Coil	Dial	Freq.		Tank Coil	Dial
40M	10.0	6.95		40M	64.5
	9.7	7.0			62.9
	9.3	7.1			59.4
	9.0	7.2			56.4
	8.7	7.3			52.0
	8.3	7.4			50.5
	8.1	7.5			47.7
	7	7.9			37.2
	6	8.5			26.1
	5	9.0			18.5
	4	9.8			9.1
	3	11.0	10.3		0 1.8
	2	12.6			
	1	13.7	13.5		100
15-20M	10	13.3			
	9	13.7			92
	8.8	13.9			88.2
	8.6	14.0			86.5
	7.9	14.5			77.8
	7.0	15.2			66.8
	6.0	16.2			49.4
	5.0	17.3			39.7
15M	4	19.0	21.4-10.7		25.0
		21.5			10.2
	3	21.2			
	2	24.3			
	1	26.5			

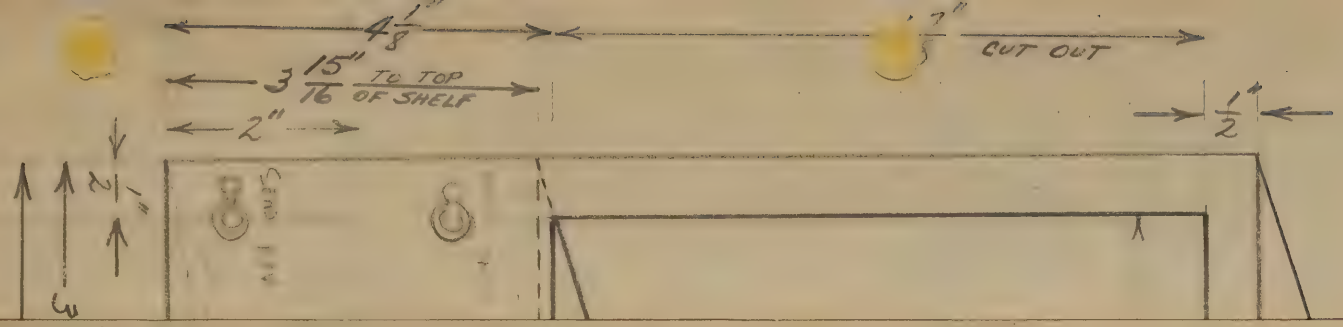
Req'd
One

Req'd
One

16 ga. Steel

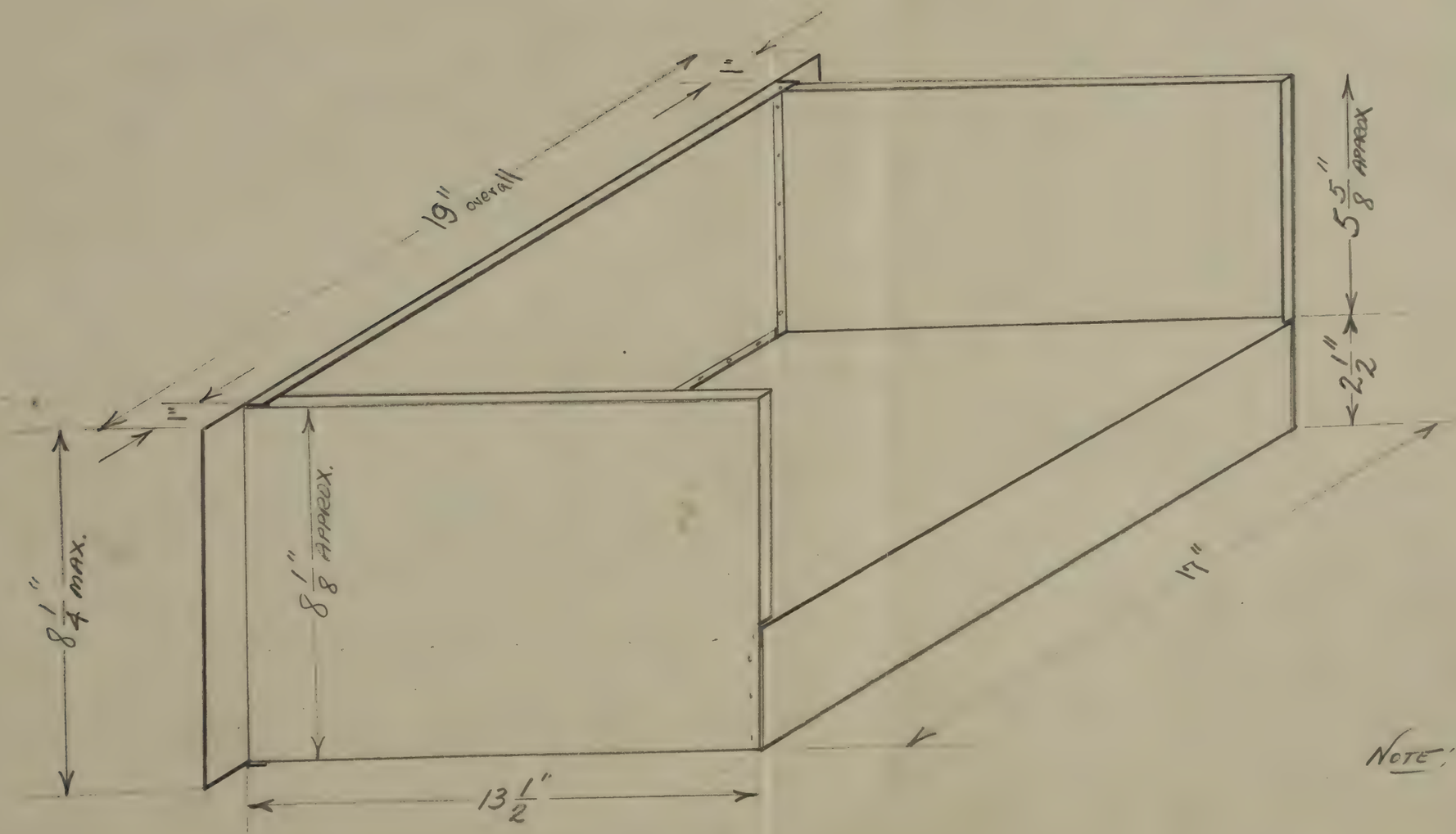


ALL FLANGES = 3/8"


4 1/8"
CUT OUT
3 15/16" TO TOP OF SHELF
2"
1/2"
2 1/4"
3"

Req'd
One

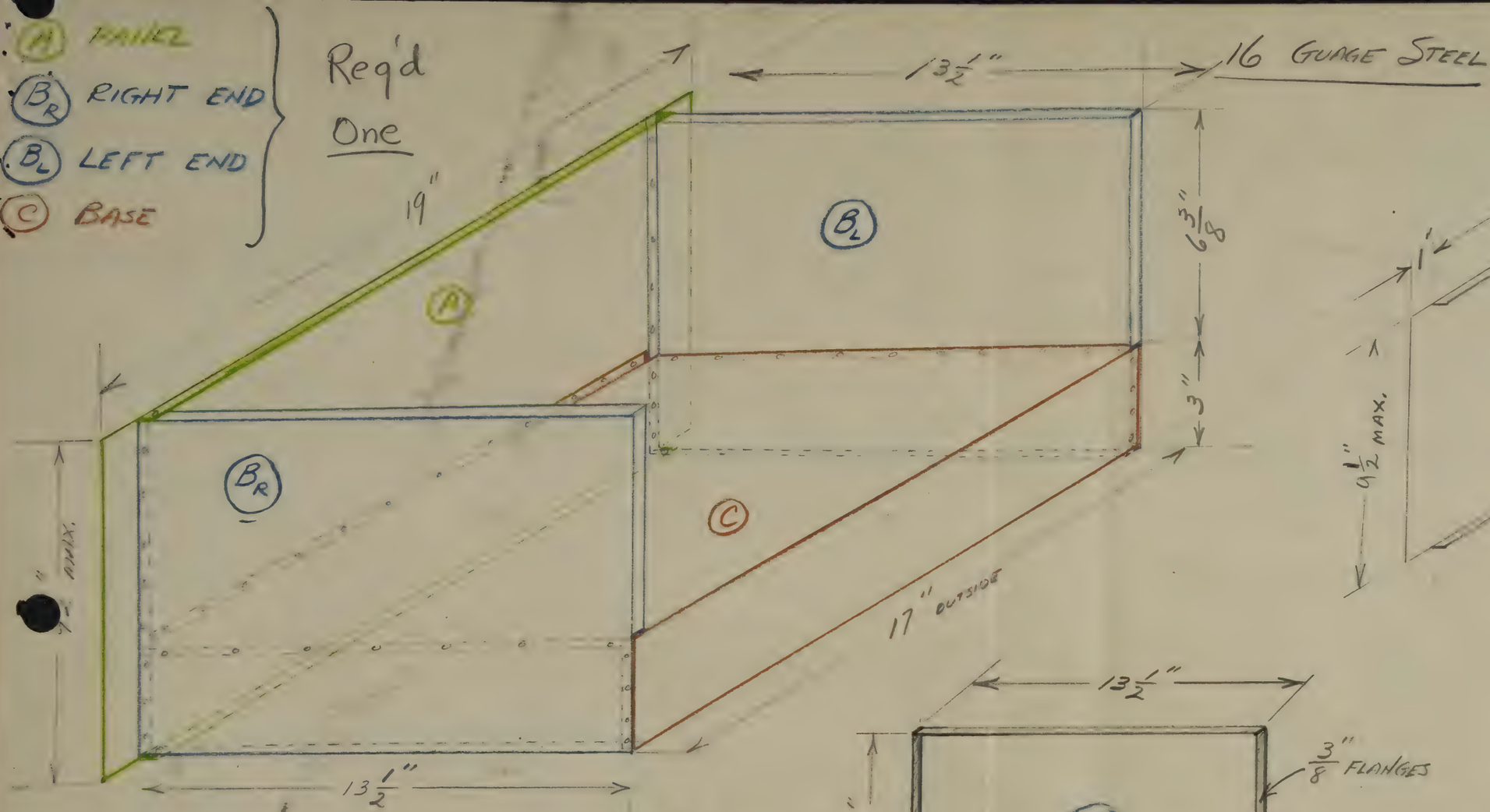
16 ga. Steel.

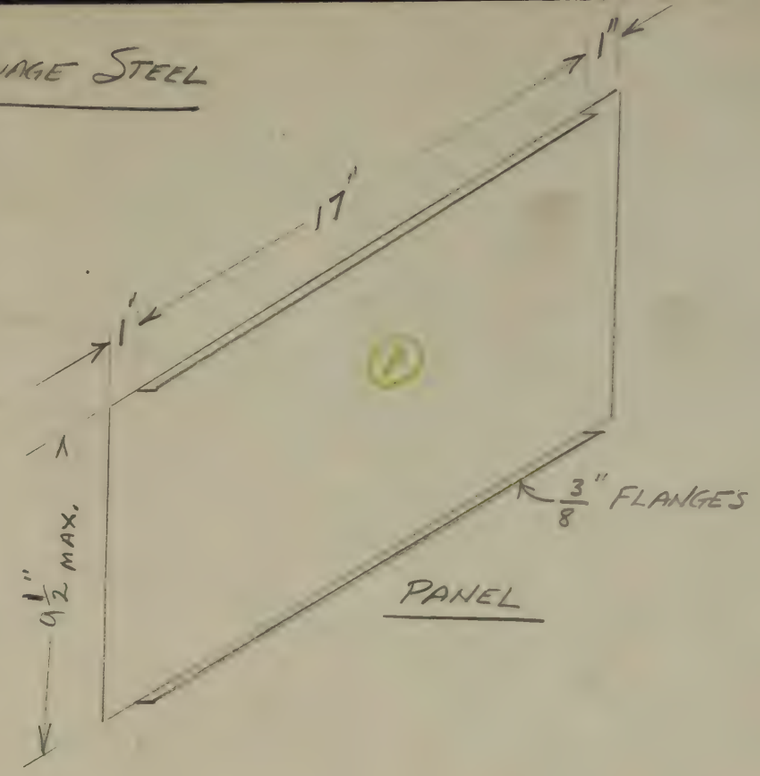


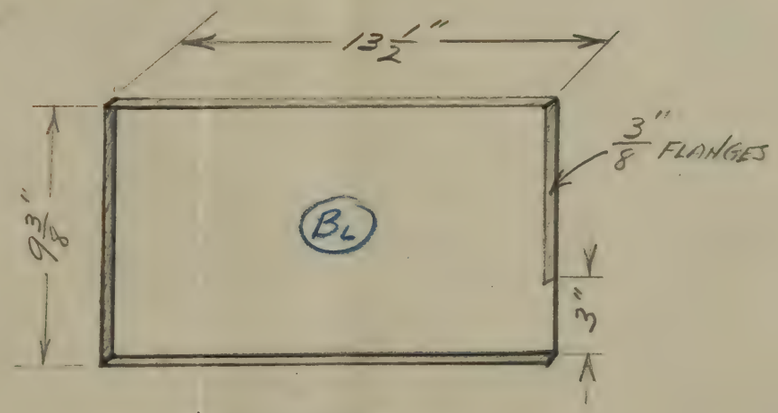
NOTE: ALL FLANGES = 3/8"

(A) PANEL
(B_R) RIGHT END
(B_L) LEFT END
(C) BASE

Req'd
One



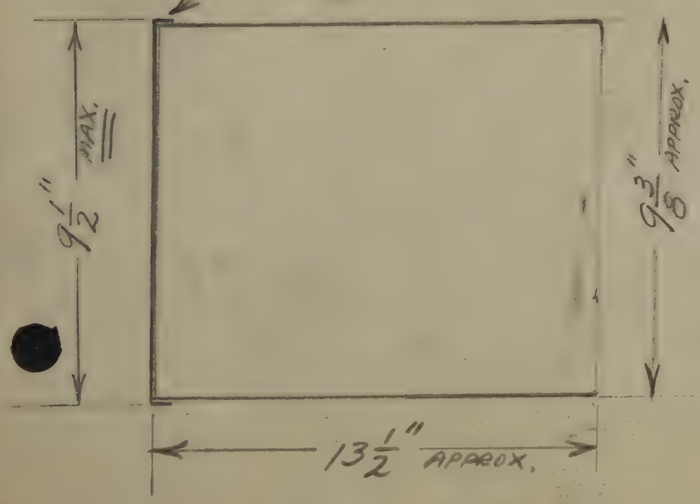




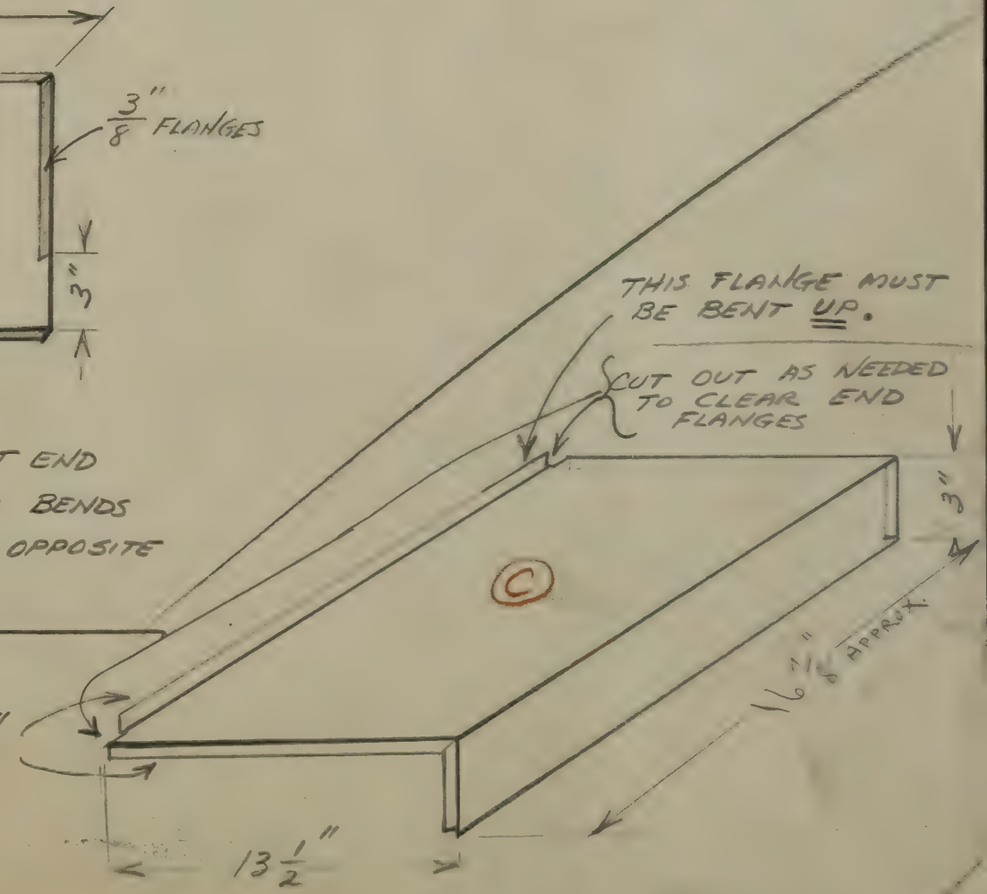
LEFT END

NOTE! MAKE (B_R) - RIGHT END TO MATCH, WITH BENDS ON FLANGES IN OPPOSITE DIRECTION.

NOTE! FRONT PANEL FLANGES GO OVER END PIECES.



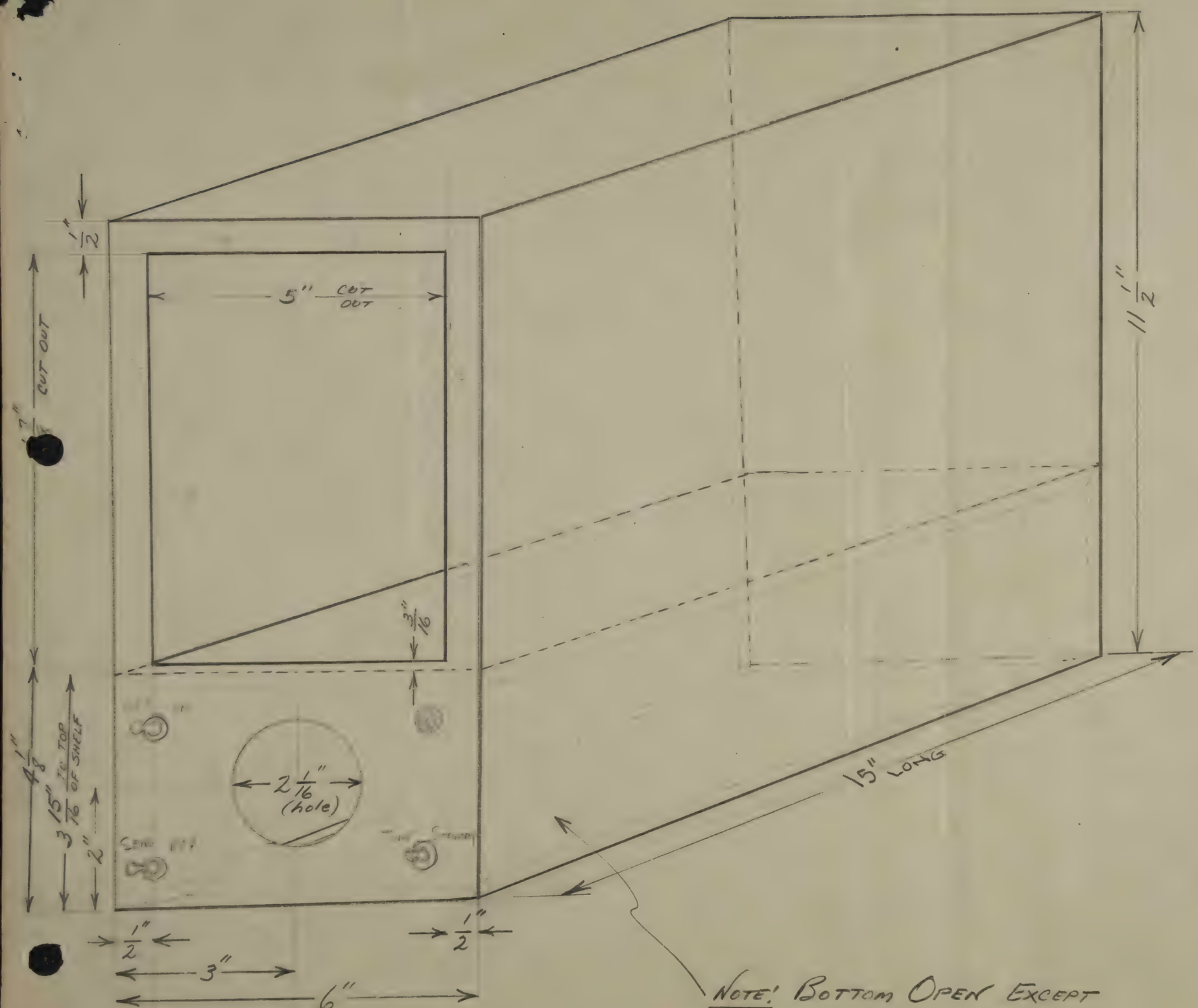
END VIEW



ALL FLANGES - 3/8"

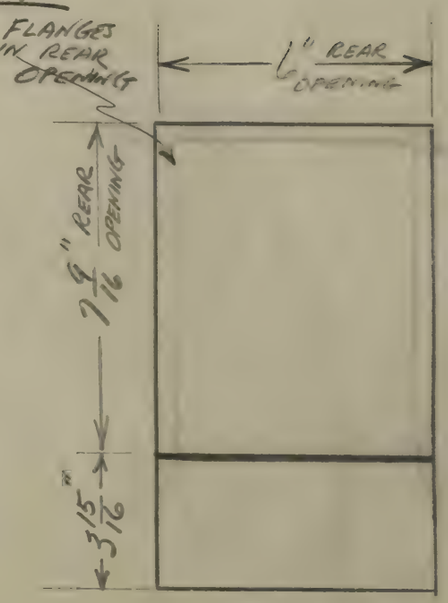
Req'd One

16 ga Sheet Steel



NOTE! BOTTOM OPEN EXCEPT FOR 3/8" FLANGE ON ALL FOUR SIDES.

NOTE! NO FLANGES IN REAR OPENING



BACK VIEW

Instruction Sheet

A-4763

STANCOR

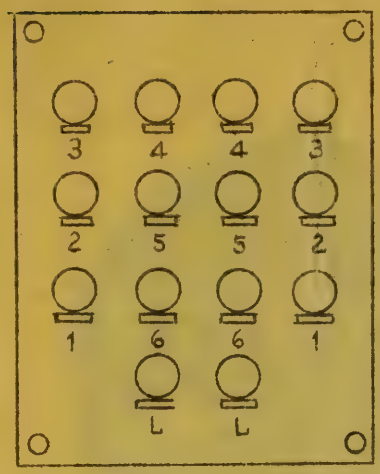
Like thousands of other Stancor customers you will find that this unit fulfills every Stancor claim.

This unit carries the usual R. M. A. 90 day guarantee against defects in materials and workmanship.

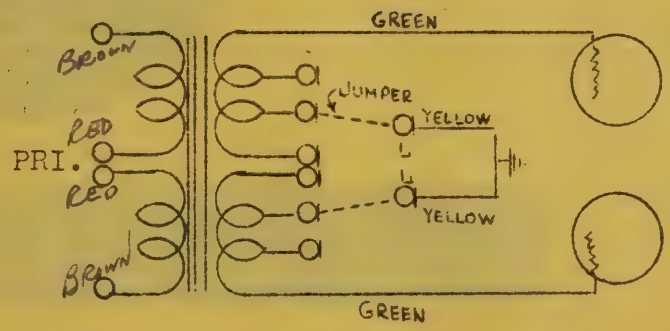
When this unit is used to replace a defective part, carefully check all circuits to see that the cause of trouble has been eliminated.

WARNING - Check line voltage and frequency - these must correspond to those of this unit, otherwise the guarantee of the unit ceases.

AA/G/DF



TERMINAL	RATIO PRI. TO 1/2 SEC.
#1	1.25:1
#2	1.50:1
#3	1.75:1
#4	2.0:1
#5	2.25:1
#6	3.2:1



POLY-PEDANCE DRIVER TRANSFORMER
INSTRUCTION SHEET

The Poly-Pedance Driver Transformer is built with two separate secondaries so that each Class "B" tube may have a different bias voltage applied.

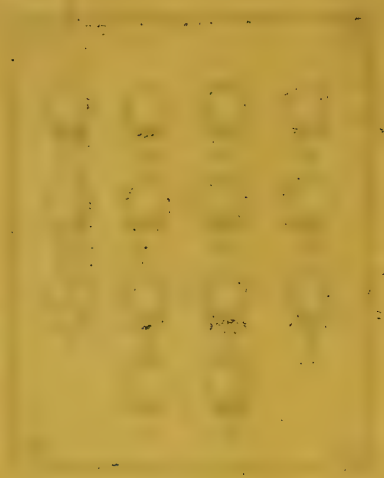
On the terminal board drawing shown above, terminals designated as "L" &"L" are connected to leads which come thru the grommet holes as yellow leads. these leads have no other connections within the transformer. The other terminals designated by numbers in the drawing have ratios as shown above.

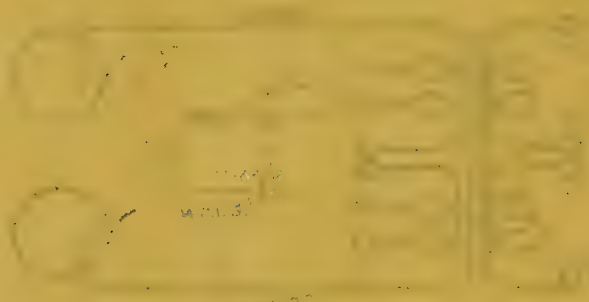
To use the transformer for subpanel wiring, connect the green leads to the tube grids and the yellow leads coming thru the same grommet to the bias supply or ground, as the case may be.
To complete the grid circuit, connect wires from lugs "L" & "L" to the ratio desired.

In the case where the grid connection is on top of the tube, the yellow leads coming thru the grommet may be disregarded and connection made directly from terminal board to grid.

Primary leads come out thru a separate grommet and are red and brown For use, the red leads are B+ and the brown leads go to the driver tube plates. Each driver plate may be metered by inserting a suitable milliameter in each red lead.

in Modulator





[illegible]-Modulator Driver Transformer is built with two separate [illegible] as that upon Circuit "B" tubes may have a different bias [illegible] applied.

[illegible] are distributed to leads which cross thru the present Defiance [illegible] flow leads. These leads have no other connections within the transformer. The other terminals (marked) are connected in the [illegible]

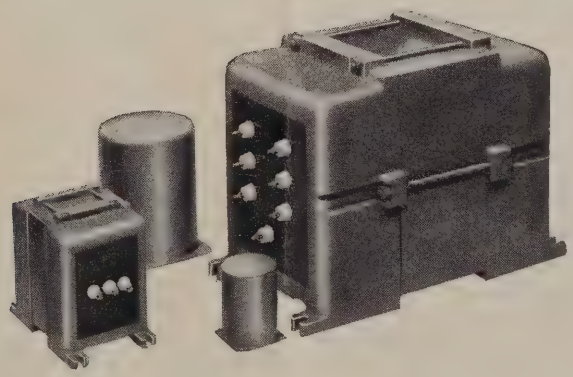
[illegible] the transformer for original wiring, connect the green leads [illegible] the same ground [illegible] the same [illegible] grid circuit, connect wires from lugs "L" & "L" [illegible]

[illegible] case where the grid connection is on top of the tube, the yellow leads, coming thru the grommet may be discarded and [illegible]

[illegible] cases cone out thru a separate grommet and are red and brown [illegible] the red leads are R-and the brown leads go to the driver [illegible] the negative plate may be secured by the rating a [illegible]

TERMINAL ARRANGEMENTS

VARIMATCH TRANSFORMERS



UNITED TRANSFORMER COMPANY

150 VARICK STREET • NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

CVM

VARIMATCH TRANSFORMERS

The ever increasing number of vacuum tubes available for audio and RF applications has increased the difficulty of obtaining transformers suitable for matching to the various correct tube loads. This is particularly an important factor in transmitter operation where a very wide range in the operating condition of the class C RF tubes is encountered. It also, however, applies equally strongly to audio tubes, as in addition to the normal operation of these tubes, the plate load varies with change in plate voltage or bias.

If a standard transformer having a limited impedance range is purchased and used for a specific purpose as the "nearest thing" available, comparatively high distortion is inevitable. As a solution to these problems, UTC has developed the Varimatch transformer, which through proper design permits a very wide range of impedance matching. Varimatch units are available for modulator service, PA service, and driver service.

IMPEDANCE MATCHING

The fundamental formula for transformers applied to impedance matching service is well known to radio men. This formula states that the impedance ratio of a transformer is directly proportional to the square of the turns. Frequency is no factor in this formula, and it is therefore apparent that the impedance ratio of a transformer, particularly one of good design, will be uniform throughout the entire audio range. Fig. 1 illustrates an ideal transformer. As an example of the application of an impedance matching transformer, let us refer to Fig. 2, which illustrates a transformer of ratio 1:2 with a pure resistance of 100 ohms across terminals AA on the high side. If we were to measure

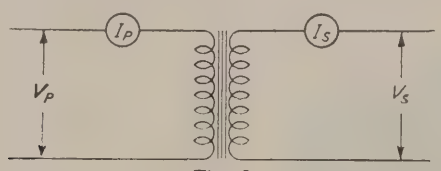


Fig. 1

the impedance of the transformer terminals BB, we would find that to all purposes the impedance would be 25 ohms, which value would remain constant throughout the entire frequency spectrum if the transformer were a perfect one. Similarly, if we were to connect a pure inductance or capacitance across the AA terminals, then terminals BB would respectively measure as a pure inductance or capacitance.

It is instructive to note therefore that if we were to tie a 2 mfd. capacitor across AA, then terminals BB would measure 8 mfds. This method is used occasionally in certain types of circuits to obtain a high capacitance where DC does not pass through the transformer. We see then that a transformer can be made to reflect any type of impedance that we choose.

Due to limitations in commercial transformers, a given unit cannot be used for a very wide range of impedance beyond a certain point. Using a transformer to obtain a given impedance ratio, but with impedance diverging considerably from that for

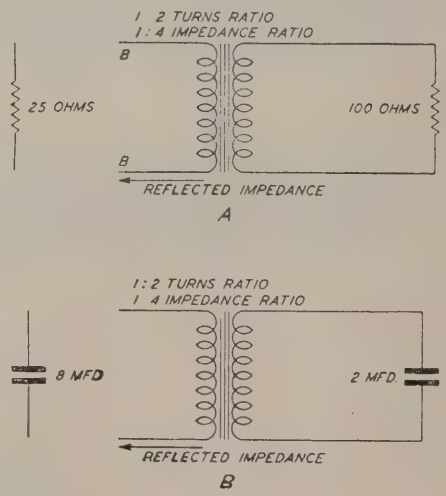


Fig. 2

which it was originally designed, frequency discrimination and loss in power transfer will result. This can be more readily understood if we analyze the actual "T" equivalent of a transformer.

COMMERCIAL TRANSFORMER

Assuming a simple transformer, as in Fig. 3A, we find that, in addition to the power transfer characteristics of the unit, we have a primary inductance which shunts our source impedance; a leakage reactance which, in effect, operates in series with our load, and a distributed capacitance, which can be lumped to shunt the load. This simplied form is indicated in Fig. 3B. As we reduce the frequency feeding into this transformer, the impedance of the primary inductance decreases. This decrease may reach the point where some of the power, which would nor-

mally be transferred from primary to secondary, is shunted through this inductance. Similarly, as the frequency increases, the impedance of the distributed

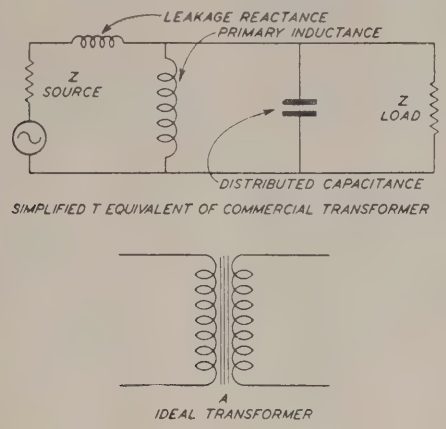


Fig. 3

capacitances decreases and shunts some of the power, which would normally pass through the load.

The third element to be considered is the leakage reactance, whose impedance increases with frequency and produces a strong series loss, at the higher frequencies. The effects of primary inductance, distributed capacitance, and leakage reactance, since they are related with primary and secondary impedances, become variable, depending upon these impedances.

TRANSFORMERS FOR MODULATION SERVICE

Several factors must be remembered in coupling the modulator and final stages in a transmitter employing high level modulation. These may be enumerated as:

1. The audio output should be approximately 50% of the class C input of the RF Stage.
2. The actual audio output available for modulation is equal to the audio output of the modulator tubes minus the losses in the coupling unit.
3. The impedance ratio of any two windings on the same core is equal to the square of the turns ratio.
4. The primary impedance of a transformer depends upon the secondary load.

While the first factor mentioned above is commonly known and applied, the second factor is one which is frequently overlooked. A highly efficient coupling device involves considerable design and care. Some contemporary transformers recently tested in the UTC audio laboratories have shown as much as 3 DB loss. While this seems to be an insignificant amount in terms of DB, it actually means a transfer efficiency of 50%. In other words, if 100 watts were available from the modulator tubes, only 50 watts would be delivered as actual power to the class C stage. Naturally, 100% modulation could not be obtained. To reduce these losses, UTC transformer core materials are operated at conservative flux densities, the resistance of the windings is kept at a small value as compared to the matched impedance, and low leakage reactance is effected by proper interleaving of windings.

Analyzing factors 3 and 4 mentioned above, it is seen that the turns ratio of a transformer definitely limits its application. This is an important factor in modulator work as the number of combinations of modulator tubes and operating conditions available, and class C combinations possible, is almost unlimited. Standard transformers as made in the past will generally take care of only one combination of modulator and final stage, and since only a limited number of these transformers have been available, the amateur frequently found it necessary to use a transformer which was "the nearest thing" to the actual transformer required for the particular application. While a 20% mismatch caused by such an occurrence does not represent a serious loss in power, it greatly reduces the undistorted power available from a class B modulator because optimum plate load is not reflected to the tubes. The UTC Varimatch transformer eliminates this difficulty through the use of a combination of tapped windings affording an extremely wide range in impedance matching.

Fig. 4 illustrates in chart form some of the various impedance combinations available.

In many cases the specified plate to plate load impedance for the modulator tubes does not coincide with the values listed in the left hand column of the impedance chart. If such is the case, select the value nearest the specified plate to plate impedance for the tubes to be used in the modulator; then the available secondary load impedances are calculated by multiplying the values listed under secondary impedances by the ratio of the plate to plate impedance of the modulator to the value selected from the left hand column, that is

$$R_L = \frac{\text{P to P load impedance of modulator tubes}}{\text{primary impedance in left hand column}}$$

multiplied by secondary impedance listed in right hand columns.

FOR EXAMPLE: The modulator is to use 2 838's operating at 1250 V. The plate to plate load impedance of the 838's under these conditions is 11,200 ohms. The power output is 260 watts. With this AF output the DC input to the class C stage should be 520 watts. If the class C plate voltage is 2500 V the plate current will be 208 MA; giving an RF load impedance of 12,000 ohms.

The nearest primary impedance to the desired value is 12,000 ohms plate to plate and secondary taps are available to give 12,500 ohms.

Substituting in the formula

$$\text{Secondary } R_L = \frac{11{,}200}{12{,}000} \times 12{,}500$$

$$= 11{,}700 \text{ (secondary impedance)}$$

The difference between the required 12,000 RF load impedance and the calculated available load impedance of 11,700, gives a match within 2½%.

Some typical modulator operating conditions and impedances for use with these Varimatch units are noted on the following pages.

TERMINAL ARRANGEMENT—CVM-0 to CVM-5 Inclusive

PRIMARY		SECONDARY												
P to P Imp.	P-B-B-P	Join 9 & 10 Con. to 7 & 12	Join 9 & 10 Con. to 8 & 12	Join 9 & 10 Con. to 8 & 11	Join 8 & 9 Con. to 7 & 12	Join 7 & 9 10 & 12 Con. to 7 & 10	Join 8 & 9 10 & 11 Con. to 8 & 10	Join 3 & 4 Con. to 1 & 6	Join 3 & 4 Con. to 2 & 6	Join 2 & 3 Con. to 1 & 6	Join 3 & 4 Con. to 2 & 5	Join 1 & 3 4 & 6 Con. to 1 & 4	Join 7 & 11 8 & 12 Con. to 7 & 8	Join 1 & 5 2 & 6 Con. to 1 & 2
Line to RF	500 ohms connected to 7 and 8; join 7 to 11 and 8 to 12							15000	9300	7700	5000	3700		
Line to RF	500 ohms connected to 1 and 2, join 1 to 5 and 2 to 6	16.000	11.000	8000	6800	4000	2000							
2000	2-3-4-5	8600	6350	4300	3620	2150	1070						200	
2000	1-2-5-6	15.700	11.400	7900	6550	3920	1950						350	
3000	2-3-4-5	13.000	9400	6500	5500	3240	1620						300	
3000	1-2-5-6	23.500	17.000	11.800	10.000	5900	2950						520	
3800	2-3-4-5	16.400	12.000	8200	7000	4100	2050						380	
3800	1-2-5-6	29.800	21.500	15.000	12.600	7500	3740						660	
4000	2-3-4-5	17.400	12.500	8650	7300	4300	2160						400	
4000	8-9-10-11							5500	3450	2850	1850	1380		250
5000	2-3-4-5	21.600	15.700	10.800	9150	5400	2700						500	
5000	8-9-10-11							7000	4300	3500	2300	1730		300
6000	1-3-4-6	8600	6350	4300	3620	2140	1070						200	
6000	8-9-10-11							8300	5150	4250	2750	2180		370
6600	1-3-4-6	9500	7000	4750	4000	2350	1180						220	
6600	8-9-10-11							9100	5650	4660	3000	2400		405
7000	1-3-4-6	10.000	7300	5050	4280	2500	1250						230	
7000	8-9-10-11							9700	6000	5000	3200	2400		430
8000	1-3-4-6	12.000	8400	5800	4900	2900	1440						270	
8000	8-9-10-11							11000	6900	5650	3700	2760		500
9000	1-3-4-6	13.000	9400	6500	5500	3240	1620						300	
9000	8-9-10-11							12500	7750	6300	4150	3100		550
9000	7-9-10-12							6200	3900	3200	2050	1550		275
10000	1-3-4-6	14.400	10,500	7200	6100	3600	1800						330	
10000	8-9-10-11							14000	8600	7100	4600	3450		600
10000	7-9-10-12							6900	4300	3500	2300	1740		310
12000	1-3-4-6	17.400	12.500	8700	7250	4320	2150						400	
12000	7-9-10-12							8300	5150	4250	2750	2070		370
14000	7-9-10-12							9700	6000	4900	3200	2440		430
16000	7-9-10-12							11000	6900	5600	3700	2780		500
18000	7-9-10-12							12500	7750	6300	4150	3140		550
				ADDED VALUES FOR CVM4 AND CVM5										
14000	13-3-4-14	11.600	8100	5600	4720	2800	1400						260	
16000	13-3-4-14	13.200	9300	6400	5400	3200	1600						300	
18000	13-3-4-14	15.000	10.400	7200	6100	3600	1800						340	
20000	13-3-4-14	16.700	11.600	8000	6800	4000	2000						375	
22000	13-3-4-14	18.300	12.800	8800	7500	4400	2200						410	

P to P Imp.	P-B-B-P	Join 3 & 4 Con. to 13 & 14	Join 3 & 4 Con. to 1 & 14	Join 4 & 6 Con. to 13 & 14	Join 3 & 4 Con. to 13 & 5	Join 2 & 3 Con. to 13 & 14	Join 3 & 13 4 & 14 Con. to 4 & 13	Join 1 & 5 2 & 6 Con. to 1 & 2
14000	7-9-10-12	17.600	13.500	7000	9000	10.800	4400	430
16000	7-9-10-12	20.000	15.500	8000	10.300	12.400	5050	500
18000	7-9-10-12	22.400	17.400	9000	11.500	13.900	5650	550

TUBE COMBINATIONS — MAXIMUM AUDIO

CVM-0 — 15 Watts

Primary Impedance	27,000	14,000	10,000	8,000	7,000	6,000	5,000	4,000
Push Pull	38	31-33-49 46-47-2A5 59 Pent. 89 Pent. 42	6A6-19-53 49-79-89 43-19 59-71A 6B5-6F6	2A5 A Prime 42 A Prime 45-43-50 6V6 ABI		46-59 Class B 6F6 AB	6L6-250V. 2A3-6A3 6A5G	25L6 48
Single		38 49 class B 89 class B	10-41-42	59 Pent. 89 Pent	6F6 46-42-47 49-89-31 2A5-33	31-46-59		43-59-45 71A-43-50

CVM-1 — 30 Watts

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
2A3's AB	3000 ohms	300 V.	— 62 V.	15 W.	30 W.
2-45's AB	3200 ohms	275 V.	— 68 V.	12 W.	24 W.
6N7	10000 ohms	300 V.	0	10 W.	20 W.
6N7	5000 ohms	300 V.	0	20 W.	40 W.
46's	6000 ohms	450 V.	0	25 W.	50 W.
2-6L6's Class AB_1	6600 ohms	400 V.	— 23 V.	30 W.	60 W.

CVM-2 — 60 Watts

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
6N7	5000 ohms	300 V.	0	20 W.	40 W.
2-46's	6000 ohms	450 V.	0	25 W.	50 W.
4-46's	3000 ohms	450 V.	0	50 W.	100 W.
2-6L6's Class AB_1	6600 ohms	400 V.	— 23 V.	30 W.	60 W.
2-6L6's AB_2	3800 ohms	400 V.	— 25 V.	60 W.	120 W.
4-6L6's AB_1	3300 ohms	400 V.	— 23 V.	60 W.	120 W.
TZ20	6100 ohms	500 V.	0	40 W.	80 W.

CVM-3 — 125 Watts

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
4-46's	3000 ohms	450 V.	— 20 V.	50 W.	100 W.
2-6L6's AB_2	3800 ohms	400 V.	— 25 V.	60 W.	120 W.
4-6L6's AB_2	1900 ohms	400 V.	— 25 V.	120 W.	240 W.
35 T's	10000 ohms	1000 V.	— 25 V.	125 W.	250 W.
	6600 ohms	750 V.	— 35 V.	90 W.	180 W.
845's AB	4600 ohms	1000 V.	— 175 V.	75 W.	150 W.
	8800 ohms	1250 V.	— 225 V.	105 W.	210 W.
809's	5200 ohms	500 V.	0	60 W.	120 W.
809's	8400 ohms	750 V.	— 5 V.	100 W.	200 W.
TZ20	12000 ohms	800 V.	0	70 W.	140 W.
HK54	6000 ohms	750 V.	0	108 W.	216 W.

CVM-4 — 300 Watts

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
25 T's	10000 ohms	1000 V.	— 35 V.	115 W.	230 W.
	12800 ohms	1250 V.	— 45 V.	130 W.	260 W.
	16000 ohms	1500 V.	— 60 V.	140 W.	280 W.
203 H's 203A's or 211's	6900 ohms	1000 V.	— 35 V.	200 W.	400 W.
	9000 ohms	1250 V.	— 45 V.	260 W.	520 W.
838's	7600 ohms	1000 V.	0	200 W.	400 W.
	11200 ohms	1250 V.	— 16 V.	260 W.	520 W.
805's	6700 ohms	1250 V.	0	300 W.	600 W.
HK 354's	10000 ohms	1500 V.	— 125 V.	280 W.	560 W.
HF-100's	7000 ohms	1000 V.	— 35 V.	200 W.	400 W.
	12000 ohms	1500 V.	— 52 V.	260 W.	520 W.
ZB-120's	4800 ohms	750 V.	0	150 W.	300 W.
	7000 ohms	1000 V.	0	200 W.	400 W.
	9000 ohms	1250 V.	0	245 W.	490 W.
	11000 ohms	1500 V.	— 9 V.	300 W.	600 W.
808's	13000 ohms	1250 V.	— 15 V.	190 W.	380 W.
100-TH's	5200 ohms	1000 V.	0	200 W.	400 W.
	7200 ohms	1250 V.	0	250 W.	500 W.
	9600 ohms	1500 V.	— 22 V.	300 W.	600 W.
100-TL's	5000 ohms	1000 V.	0	210 W.	420 W.
	10000 ohms	1500 V.	— 22 V.	300 W.	600 W.
811's	15000 ohms	1250 V.	0	175 W.	350 W.
811's	18000 ohms	1500 V.	— 9 V.	225 W.	450 W.
812's	15000 ohms	1250 V.	— 36 V.	175 W.	350 W.
812's	18000 ohms	1500 V.	— 46 V.	225 W.	450 W.
TZ40	9000 ohms	1000 V.	0	150 W.	300 W.
TZ40	6900 ohms	1000 V.	0	175 W.	350 W.
HK54	12500 ohms	1500 V.	— 45 V.	200 W.	400 W.

CVM-5 — 600 Watts

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
203 H's, 203 A's or 211's	9000 ohms	1250 V.	— 45 V.	260 W.	520 W.
838's	11200 ohms	1250 V.	— 16 V.	260 W.	520 W.
805's	6700 ohms	1250 V.	0	300 W.	600 W.
	8200 ohms	1500 V.	— 16 V.	370 W.	740 W.
203H	10000 ohms	1750 V.	— 65 V.	370 W.	740 W.
	15000 ohms	2000 V.	— 75 V.	450 W.	900 W.
204A or HF 300	7800 ohms	1500 V.	— 40 V.	400 W.	800 W.
	8200 ohms	1750 V.	— 50 V.	500 W.	1 KW.
	8800 ohms	2000 V.	— 60 V.	600 W.	1200W.
	13120 ohms	2500 V.	— 85 V.	650 W.	1300W.
4-203A's	4500 ohms	1250 V.	— 45 V.	500 W.	1 KW.
4-838's	5600 ohms	1250 V.	— 16 V.	500 W.	1 KW.
4-805's	3350 ohms	1250 V.	0	600 W.	1200W.
HK 354's	15000 ohms	2000 V.	— 175 V.	370 W.	740 W.
	17500 ohms	2500 V.	— 225 V.	460 W.	920 W.
HF-100	16000 ohms	1750 V.	— 62 V.	350 W.	700 W.
HF-200	11000 ohms	2000 V.	— 92 V.	500 W.	1000W.
100-TH	16000 ohms	2000 V.	Adj.	380 W.	760 W.
	22000 ohms	2500 V.	Adj.	460 W.	920 W.
250-TH	2360 ohms	1000 V.	0	350 W.	700 W.
	3280 ohms	1250 V.	0	540 W.	1080W.
	4200 ohms	1500 V.	0	650 W.	1300W.
	6600 ohms	1500 V.	— 30 V.	500 W.	1000W.
813 Class AB_2 EC2 = 750 V.	16000 ohms	2000 V.	— 90 V.	455 W.	910 W.
	18500 ohms	2250 V.	— 90 V.	515 W.	1030W.
4-125A Class AB_2 EC2 = 350 V.	7200 ohms	1500 V.	— 41 V.	350 W.	700 W.
	13600 ohms	2000 V.	— 45 V.	350 W.	700 W.
	22200 ohms	2500 V.	— 43 V.	400 W.	800 W.
4-250A Class AB_2 EC2 = 300 V.	6250 ohms	1500 V.	— 64 V.	310 W.	620 W.
	9170 ohms	2000 V.	— 88 V.	460 W.	920 W.
	11400 ohms	2500 V.	— 90 V.	625 W.	1250W.

DRIVER VARIMATCH UNITS

Another application where impedance matching must be considered is in driver transformers for class AB and class B amplifiers. Since in a class B amplifier only one-half of the input transformer secondary functions at a time, impedance matching must be considered from the total primary to one-half of the secondary.

To make our analysis simple, let us assume that we have a perfect transformer of the correct ratio for the purpose intended. The impedance reflected into the grid circuit will be equal to the impedance ratio (total primary to ½ secondary) multiplied by the source impedance. It is desirable to keep this impedance as reflected in the grid circuit much lower than the impedance to which the grid is driven at high levels. That is, if our grid drops from infinity to 200 ohms at maximum output, the reflected impedance, which the transformer shows in the grid circuit, should preferably not exceed more than a fraction of this 200 ohms.

As an example, let us take the case of an amplifier using type 46 tubes, operating in class B. If we check back to a typical transformer for these tubes, we find a ratio, total primary to ½ secondary, of 3.2. Since this is the voltage ratio, it must be squared to obtain the impedance ratio, which we find to be 10. If we use a 46 driver, the source impedance would be 2380 ohms. Dividing 2380 by 10, we obtain a reflected impedance in the grid circuit of 238 ohms. **The lower we can make this impedance, the further we can drive our output tubes with low grid distortion.**

While it is possible to obtain a lower grid impedance by increasing the step down ratio of our transformer, this cannot be carried too far, as a definite amount of grid driving voltage is necessary. It is also possible to obtain the same effect by using the same transformer and changing our driver tube. Let us assume that we use the same transformer with a 2A3 tube. Since the plate impedance of this tube is approximately 800 ohms and the impedance ratio of our transformer is 10, the reflected impedance in the grid circuit would be only 80 ohms. This is much less than that obtained with the 46 driver.

The use of pentodes and other high mu tubes has been frequently recommended for class B driver service. An analysis of the above paragraphs will immediately show the fallacy of this. A typical mistake in this respect is the recommendation of the 6L6 tube as a driver for high power class B systems. Since the plate resistance of this tube is 24,000 ohms, it is readily seen that the reflected impedance will be 30 times as great as that obtainable with a 2A3 tube having 800 ohms resistance. The very high impedance which the 6L6 would reflect into the grid circuit of our class B tubes would limit their power appreciably; in some cases to less than half that obtainable by using the 2A3 tube.

The UTC Varimatch driver transformers are tapped to afford various impedance ratios so that optimum operation can be obtained for a given combination of driver and output tubes.

VARIMATCH UNITS FOR PUBLIC ADDRESS SERVICE

Tubes used in PA equipment have increased considerably in number during the past few years. It is only natural that PA amplifiers be changed over to new tubes such as the beam power tubes as they become available. To eliminate obsolescence and also for use on special PA equipment, where universal matching is essential, the UTC PA Varimatch transformers have been designed. These units have secondary impedances for voice coils and lines and have a tapped primary arrangement covering many impedance combinations.

PA VARIMATCH TRANSFORMERS

UTC PA Varimatch transformers are designed with universal tapped primaries which will match practically any PA output tubes. The available connections for the CVP 1, 2, 3, 4 and 5 are as follows:

Pri. Impedance	Join	Connect to
14,000 ohms	3 to 4; 6 to 7	1-5-9 (P-B-P)
10,000 ohms	2 to 4; 6 to 8	1-5-9 (P-B-P)
8,000 ohms	————	4-5-6 (P-B-P)
7,000 ohms	1 to 4	2-6 (P-B)
6,000 ohms	1 to 4; 6 to 9	2-5-8 (P-B-P)
5,000 ohms	2 to 4; 6 to 8	3-5-7 (P-B-P)
3,000 ohms	1 to 4; 6 to 9	3-5-7 (P-B-P)

Sec. Load	Connect to	Sec. Load	Connect to
500 ohms	10 & 12	8 ohms	A & C
200 ohms	10 & 11	5 ohms	B & D
50 ohms	11 & 12	3 ohms	A & B
16 ohms	A & D	1.5 ohms	C & D

Typical tube combinations that are taken care of by these primary impedances are:

14,000 ohms—Pushpull 47's, 2A5's, 42's, and other similar pentodes
10,000 ohms—Pushpull 59 triodes, 71A's, 6B5's, 6F6 pentodes, and Class B 6A6, 19, 53, 49, 79, 89
8,000 ohms—Pushpull 250's, 245's, 43's, 2A5 triodes, 42 triodes, etc.
7,000 ohms—Single 2A5 pentode, 42 pentode, 31 triode, 33 pentode, 47 pentode, 89 pentode
6,000 ohms—Class B pushpull 46's, 59's, 6F6's fixed bias, 6L6's AB_1, single 31, 46, 59 pentode
5,000 ohms—Pushpull self bias 2A3's, 6A3's, 6L6's at 250 volts 46's at 300 volts
3,000 ohms—Pushpull fixed bias 2A3's, 6A3's

Impedances differing somewhat from the impedances noted above can be accommodated by the primary winding. A corresponding change is obtained in the secondary output impedance. In other words, if pushpull 6L6's were used at the 400 volt operating condition, the matching impedance is 6600 ohms. The 6000 ohm connections would be used for this application with the result that all secondary impedances would be increased 10%. In other words, the 5 ohm connection would be 5.5 ohms; the 200 ohm connection, 220 ohms, etc. In a similar manner, the secondary impedances can be changed up to 30% from the normal value with a corresponding change in the primary impedance. For example, if a 6 ohm voice coil were connected across the 5 ohm taps, then the primary impedance shown would be multiplied by 6. In other words, the 5000 ohm plate

—
5

to plate connection would become 6000 ohms.

LINE VARIMATCH TRANSFORMERS

UTC Line Varimatch Transformers are designed to match voice coil impedances to a 500 ohm line, where the speakers are located at some distance from the audio amplifier. The voice coil impedances available on these units range from .1 to 30 ohms, so that any speaker or group of speakers can be matched (see chart). Where speakers are to be connected in groups to one transformer, it is always preferable that parallel connection be used to eliminate the possibility of multiple resonance. It is also important to remember that if two speakers of different impedances are connected in parallel, the lower impedance speaker will develop greater power. If connected in series, the higher impedance speaker will develop greater power.

The effective impedance of a group of speakers connected to one transformer can be calculated in the following manner:

For speakers in series, add all the impedances. For example, the effective impedance of a 2 ohm and two 4 ohm speakers in series is $2 + 4 + 4 = 10$ ohms.

For identical speakers in parallel, divide the impedance of one speaker by the number of speakers used. In other words three 15 ohm speakers in parallel would have an effective impedance of $\frac{15}{3} = 5$ ohms.

For two different speakers in parallel, divide the product of their impedances by the sum of their impedances. That is, the impedance of a 4 and 12 ohm speaker in parallel would be $\frac{4 \times 12}{4 + 12} = 3$ ohms.

For a number of different speakers in parallel, add the reciprocals of the individual impedances and then take the reciprocal of this sum. If three speakers having impedances of 2, 4 and 8 ohms were connected in parallel the impedance would be $\frac{1}{1/2 + 1/4 + 1/8} = \frac{1}{.875} = 1.1$ ohms.

PARALLELING LINE VARIMATCH UNITS

If the individual speakers or groups of speakers are located at some distance from each other, separate Line Varimatch transformers must be used. The 500 ohm output of these units can then be connected in parallel to the amplifier. A single speaker, four speakers in series parallel, or nine speakers in three series—three parallel groups, will effect a direct 500 ohm impedance for matching to the amplifier. For other combinations, the 500 ohm outputs of the LVM units should be connected in parallel and then matched to the amplifier by using the correct tap on a Line Varimatch Autoformer unit. The autotransformer is tapped at 500, 250, 167, 125, 100, 83, 71, 62, 55, and 50 ohms for from 1 to ten 500 ohm lines in parallel respectively.

LINE VARIMATCH IMPEDANCE COMBINATIONS

CVL 1-2-3

Connect Voice Coil to	join	also join	Voice Coil Impedance with 500 ohms connected to A&B	Voice Coil Impedance with 500 ohms connected to B&C*	Voice Coil Impedance with 500 ohms connected to A&C
2 and 3	2 to 6	3 to 7	.4	2.5	.62
1 and 2	1 to 7	2 to 8	1.	6.25	.2
3 and 5	3 to 4	5 to 6	1.25	8.	1.25
1 and 3	1 to 6	3 to 8	2.5	16.	1.5
2 and 5	2 to 4	5 to 7	3.	20.	2.
1 and 8	2 to 7		4.	25.	2.25
1 and 6	2 to 4		4.5	28.	2.5
3 and 6	4 to 5		5.	31.	3.3
1 and 8	2 to 6		6.6	40.	3.8
1 and 5	1 to 4	5 to 8	7.5	47.	4.
2 and 6	4 to 5		8.	50.	5.
1 and 8	3 to 6		10.	63.	5.5
2 and 8	3 to 4		11.	69.	6.
2 and 7	4 to 5		12.	75.	7.
1 and 8	2 to 4		14.		7.5
1 and 6	4 to 5		15.		9.
1 and 8	5 to 6		18.		10.
2 and 8	4 to 5		20.		15.
1 and 8	4 to 5		30.		.5

CVL 10-11-12

Connect 500 ohm line to 1 & 10 Impedance	Connect to
50 ohms	1 & 2
62 ohms	1 & 3
71 ohms	1 & 4
83 ohms	1 & 5
100 ohms	1 & 6
125 ohms	1 & 7
167 ohms	1 & 8
250 ohms	1 & 9

* This connection gives a low frequency loss which is frequently desirable in PA work to eliminate the overloading of loud speakers with low frequency.

DRIVER TRANSFORMERS

Type No.	Primary Connections	Typical Driver Tubes	Secondary Connections	Turns Ratio Primary to ½ Sec.
CG-51AX	P-B	45, 2A3	G-F-F-G	2.8:1
		6F6, 6L6, 6N7	G'-F-F-G'	3.1:1
CG-53AX	P-B-P	45's, 2A3's	G-F-F-G	2:1
		6L6's	G'-F-F-G'	3:1
CG-59AX	500 Ohms —	Connect to 1 & 5 Join 3 & 4	G-F-F-G	1:1
	200 Ohms —	Connect to 2 & 5 Join 3 & 4	"	1:1.5
	50 Ohms —	Connect to 4 & 5 Join 1 & 4, 2 & 5	"	1:3
	500 Ohms —	Connect to 1 & 5 Join 3 & 4	G'-F-F-G'	1.4:1
	200 Ohms —	Connect to 2 & 5 Join 3 & 4	"	1:1
	50 Ohms —	Connect to 4 & 5 Join 1 & 4, 2 & 5	"	1:2
CG-238AX	P-B-P	Push-Pull	G-F-F-G	2:1
	P'-B-P'	Parallel	G-F-F-G	1.55:1
	P-B-P	45, 2A3	G'-F-F-G'	3:1
	P'-B-P'	6L6	G'-F-F-G'	2.5:1
CG-512	500 Ohms —	Connect to 1 & 5 Join 3 & 4	G-F-F-G	1:2.5
	200 Ohms —	Connect to 2 & 5 Join 3 & 4	"	1:3.8
	50 Ohms —	Connect to 4 & 5 Join 1 & 4, 2 & 5	"	1:7.5

P-476-CVM-7/54-10M

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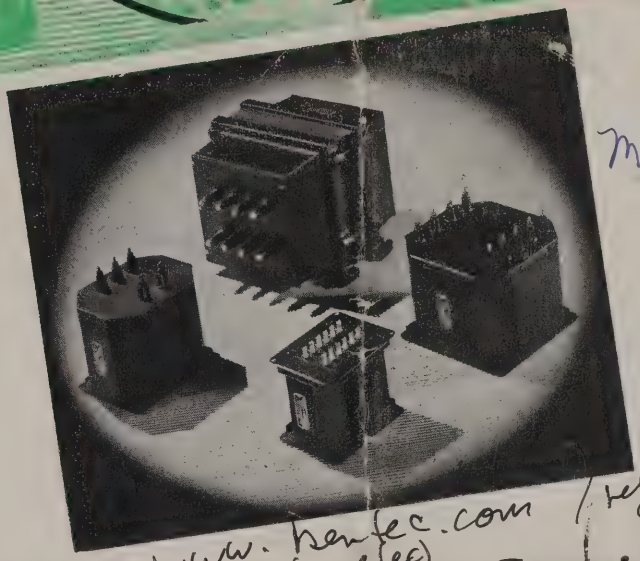

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★ Varimatch Modulation Transformers
★ Varimatch Driver Transformers
★ Varimatch PA Transformers
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VARIMATCH TRANSFORMERS...

VARIMATCH TRANSFORMERS

The ever increasing number of vacuum tubes available for audio and RF applications has increased the difficulty of obtaining transformers suitable for matching to the various correct tube loads. This is particularly an important factor in transmitter operation where a very wide range in the operating condition of the class C RF tubes is encountered. It also, however, applies equally strongly to audio tubes, as in addition to the normal operation of these tubes, the plate load varies with change in plate voltage or bias.

If a standard transformer having a limited impedance range is purchased and used for a specific purpose as the "nearest thing" available, comparatively high distortion is inevitable. As a solution to these problems, UTC has developed the Varimatch transformer, which through proper design permits a very wide range of impedance matching. Varimatch units are available for modulator service, PA service, and driver service.

IMPEDANCE MATCHING

The fundamental formula* for transformers applied to impedance matching service is well known to radio men. This formula states that the impedance ratio of a transformer is directly proportional to the square of the turns. Frequency is no factor in this formula, and it is therefore apparent that the impedance ratio of a transformer, particularly one of good design, will be uniform throughout the entire audio range. Fig. 1 illustrates an ideal transformer. As an example of the application of an impedance matching transformer, let us refer to Fig. 2, which illustrates a transformer of ratio 1:2 with a pure resistance of 100 ohms across terminals AA on the high side. If we were to measure

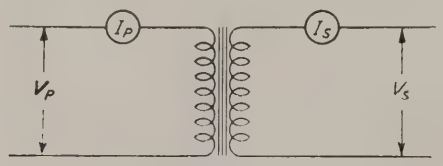

Fig. 1

the impedance of the transformer terminals BB, we would find that to all purposes the impedance would be 25 ohms, which value would remain constant throughout the entire frequency spectrum if the transformer were a perfect one. Similarly, if we were to connect a pure inductance or capacitance across the AA terminals, then terminals BB would respectively measure as a pure inductance or capacitance.

It is instructive to note therefore that if we were to tie a 2 mfd. capacitor across AA, then terminals BB would measure 8 mfds. This method is used occasionally in certain types of circuits to obtain a high capacitance where DC does not pass through the transformer. We see then that a transformer can be made to reflect any type of impedance that we choose.

Due to limitations in commercial transformers, a given unit cannot be used for a very wide range of impedance beyond a certain point. Using a transformer to obtain a given impedance ratio, but with impedance diverging considerably from that for

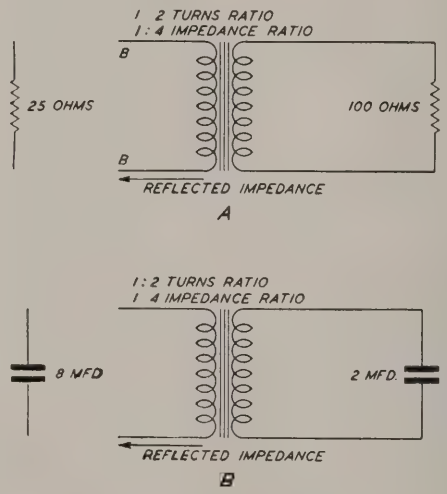

Fig. 2

which it was originally designed, frequency discrimination and loss in power transfer will result. This can be more readily understood if we analyze the actual "T" equivalent of a transformer.

COMMERCIAL TRANSFORMER

Assuming a simple transformer, as in Fig. 3A, we find that, in addition to the power transfer characteristics of the unit, we have a primary inductance which shunts our source impedance; a leakage reactance which, in effect, operates in series with our load, and a distributed capacitance, which can be lumped to shunt the load. This simplied form is indicated in Fig. 3B. As we reduce the frequency feeding into this transformer, the impedance of the primary inductance decreases. This decrease may reach the point where some of the power, which would nor-

* For complete derivation, see article by I. A. Mitchell, in "Radio", July 1936.

mally be transferred from primary to secondary, is shunted through this inductance. Similarly, as the frequency increases, the impedance of the distributed

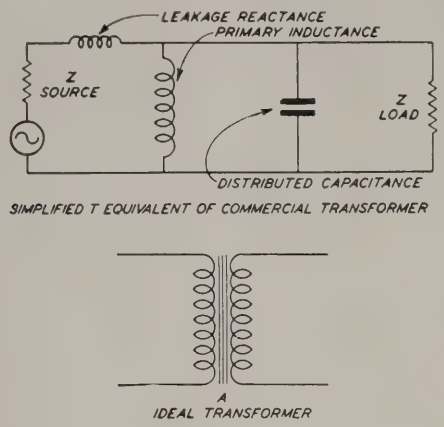

Fig. 3

capacitances decreases and shunts some of the power, which would normally pass through the load.

The third element to be considered is the leakage reactance, whose impedance increases with frequency and produces a strong series loss, at the higher frequencies. The effects of primary inductance, distributed capacitance, and leakage reactance, since they are related with primary and secondary impedances, become variable, depending upon these impedances.

TRANSFORMERS FOR MODULATION SERVICE

Several factors must be remembered in coupling the modulator and final stages in a transmitter employing high level modulation. These may be enumerated as:

1. The audio output should be approximately 50% of the class C input of the RF Stage.
2. The actual audio output available for modulation is equal to the audio output of the modulator tubes minus the losses in the coupling unit.
3. The impedance ratio of any two windings on the same core is equal to the square of the turns ratio.
4. The primary impedance of a transformer depends upon the secondary load.

While the first factor mentioned above is commonly known and applied, the second factor is one which is frequently overlooked. A highly efficient coupling device involves considerable design and care. Some contemporary transformers recently tested in the UTC audio laboratories have shown as much as 3 DB loss. While this seems to be an insignificant amount in terms of DB, it actually means a transfer efficiency of 50%. In other words, if 100 watts were available from the modulator tubes, only 50 watts would be delivered as actual power to the class C stage. Naturally, 100% modulation could not be obtained. To reduce these losses, UTC transformer core materials are operated at conservative flux densities, the resistance of the windings is kept at a small value as compared to the matched impedance, and low leakage reactance is effected by proper interleaving of windings.

Analyzing factors 3 and 4 mentioned above, it is seen that the turns ratio of a transformer definitely limits its application. This is an important factor in modulator work as the number of combinations of modulator tubes and operating conditions available, and class C combinations possible, is almost unlimited. Standard transformers as made in the past will generally take care of only one combination of modulator and final stage, and since only a limited number of these transformers have been available, the amateur frequently found it necessary to use a transformer which was "the nearest thing" to the actual transformer required for the particular application. While a 20% mismatch caused by such an occurrence does not represent a serious loss in power, it greatly reduces the undistorted power available from a class B modulator because optimum plate load is not reflected to the tubes. The UTC Varimatch transformer eliminates this difficulty through the use of a combination of tapped windings affording an extremely wide range in impedance matching.

Fig. 4 illustrates in chart form some of the various impedance combinations available.

In many cases the specified plate to plate load impedance for the modulator tubes does not coincide with the values listed in the left hand column of the impedance chart. If such is the case, select the value nearest the specified plate to plate impedance for the tubes to be used in the modulator; then the available secondary load impedances are calculated by multiplying the values listed under secondary impedances by the ratio of the plate to plate impedance of the modulator to the value selected from the left hand column, that is

$$R_L = \frac{\text{P to P load impedance of modulator tubes}}{\text{primary impedance in left hand column}}$$

multiplied by secondary impedance listed in right hand columns.

FOR EXAMPLE: The modulator is to use 2 838's operating at 1250 V. The plate to plate load impedance of the 838's under these conditions is 11,200 ohms. The power output is 260 watts. With this AF output the DC input to the class C stage should be 520 watts. If the class C plate voltage is 2500 V the plate current will be 208 MA; giving an RF load impedance of 12,000 ohms.

The nearest primary impedance to the desired value is 12,000 ohms plate to plate and secondary taps are available to give 12,500 ohms.

Substituting in the formula

$$\text{Secondary } R_L = \frac{11{,}200}{12{,}000} \times 12{,}500$$

$= 11{,}700$ (secondary impedance)

The difference between the required 12,000 RF load impedance and the calculated available load impedance of 11,700, gives a match within $2\frac{1}{2}$%.

Some typical modulator operating conditions and impedances for use with these Varimatch units are noted on the following pages.

TERMINAL ARRANGEMENT—VM-0 to VM-5 Inclusive

PRIMARY		SECONDARY												
P to P Imp.	P-B-B-P	Join 9 & 10 Con. to 7 & 12	Join 9 & 10 Con. to 8 & 12	Join 9 & 10 Con. to 8 & 11	Join 8 & 9 Con. to 7 & 12	Join 7 & 9 10 & 12 Con. to 7 & 10	Join 8 & 9 10 & 11 Con. to 8 & 10	Join 3 & 4 Con. to 1 & 6	Join 3 & 4 Con. to 2 & 6	Join 2 & 3 Con. to 1 & 6	Join 3 & 4 Con. to 2 & 5	Join 1 & 3 4 & 6 Con. to 1 & 4	Join 7 & 11 8 & 12 Con. to 7 & 8	Join 1 & 5 2 & 6 Con. to 1 & 2
Line to RF	500 ohms connected to 7 and 8; join 7 to 11 and 8 to 12							15000	9300	7700	5000	3700		
Line to RF	500 ohms connected to 1 and 2, join 1 to 5 and 2 to 6	16.000	11.000	8000	6800	4000	2000							
2000	2-3-4-5	8600	6350	4300	3620	2150	1070						200	
2000	1-2-5-6	15.700	11.400	7900	6550	3920	1950						350	
3000	2-3-4-5	13.000	9400	6500	5500	3240	1620						300	
3000	1-2-5-6	23.500	17.000	11.800	10.000	5900	2950						520	
3800	2-3-4-5	16.400	12.000	8200	7000	4100	2050						380	
3800	1-2-5-6	29.800	21.500	15.000	12.600	7500	3740						660	
4000	2-3-4-5	17.400	12.500	8650	7300	4300	2160						400	
4000	8-9-10-11							5500	3450	2850	1850	1380		250
5000	2-3-4-5	21.600	15.700	10.800	9150	5400	2700						500	
5000	8-9-10-11							7000	4300	3500	2300	1730		300
6000	1-3-4-6	8600	6350	4300	3620	2140	1070						200	
6000	8-9-10-11							8300	5150	4250	2750	2180		370
6600	1-3-4-6	9500	7000	4750	4000	2350	1180						220	
6600	8-9-10-11							9100	5650	4660	3000	2400		405
7000	1-3-4-6	10.000	7300	5050	4280	2500	1250						230	
7000	8-9-10-11							9700	6000	5000	3200	2400		430
8000	1-3-4-6	12.000	8400	5800	4900	2900	1440						270	
8000	8-9-10-11							11000	6900	5650	3700	2760		500
9000	1-3-4-6	13.000	9400	6500	5500	3240	1620						300	
9000	8-9-10-11							12500	7750	6300	4150	3100		550
9000	7-9-10-12							6200	3900	3200	2050	1550		275
10000	1-3-4-6	14.400	10,500	7200	6100	3600	1800						330	
10000	8-9-10-11							14000	8600	7100	4600	3450		600
10000	7-9-10-12							6900	4300	3500	2300	1740		310
12000	1-3-4-6	17.400	12.500	8700	7250	4320	2150						400	
12000	7-9-10-12							8300	5150	4250	2750	2070		370
14000	7-9-10-12							9700	6000	4900	3200	2440		430
16000	7-9-10-12							11000	6900	5600	3700	2780		500
18000	7-9-10-12							12500	7750	6300	4150	3140		550
				ADDED VALUES FOR VM4 AND VM5										
14000	13-3-4-14	11.600	8100	5600	4720	2800	1400						260	
16000	13-3-4-14	13.200	9300	6400	5400	3200	1600						300	
18000	13-3-4-14	15.000	10.400	7200	6100	3600	1800						340	
20000	13-3-4-14	16.700	11.600	8000	6800	4000	2000						375	
22000	13-3-4-14	18.300	12.800	8800	7500	4400	2200						410	

P to P Imp.	P-B-B-P	Join 3 & 4 Con. to 13 & 14	Join 3 & 4 Con. to 1 & 14	Join 4 & 6 Con. to 13 & 14	Join 3 & 4 Con. to 13 & 5	Join 2 & 3 Con. to 13 & 14	Join 3 & 13 4 & 14 Con. to 4 & 13	Join 1 & 5 2 & 6 Con. to 1 & 2
14000	7-9-10-12	17.600	13.500	7000	9000	10.800	4400	430
16000	7-9-10-12	20.000	15.500	8000	10.300	12.400	5050	500
18000	7-9-10-12	22.400	17.400	9000	11.500	13.900	5650	550

TUBE COMBINATIONS

VM-0

Primary Impedance	27,000	14,000	10,000	8,000	7,000	6,000	5,000	4,000
Push Pull	38	31-33-49 46-47-2A5 59 Pent. 89 Pent. 42	6A6-19-53 49-79-89 43-19 59-71A 6B5-6F6	2A5 A Prime 42 A Prime 45-43-50 6V6 ABI		46-59 Class B 6F6 AB	6L6-250V. 2A3-6A3 6A5G	25L6 48
Single		38 49 class B 89 class B	10-41-42	59 Pent. 89 Pent.	6F6 46-42-47 49-89-31 2A5-33	31-46-59		43-59-45 71A-43-50

VM-1

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
2A3's AB	3000 ohms	300 V.	—62 V.	15 W.	30 W.
2-45's AB	3200 ohms	275 V.	—68 V.	12 W.	24 W.
1602's, 210's	8000 ohms	425 V.	—50 V.	25 W.	50 W.
53 or 6A6	10000 ohms	300 V.	0	10 W.	20 W.
2-53's or 6A6's	5000 ohms	300 V.	0	20 W.	40 W.
46's	6000 ohms	450 V.	0	25 W.	50 W.
2-6L6's Class AB_1	6600 ohms	400 V.	—23 V.	30 W.	60 W.
841	7000 ohms	425 V.	— 5 V.	28 W.	56 W.

VM-2

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
2 53's or 6A6's	5000 ohms	300 V.	0	20 W.	40 W.
2-46's	6000 ohms	450 V.	0	25 W.	50 W.
4-46's	3000 ohms	450 V.	0	50 W.	100 W.
2-6L6's Class AB_1	6600 ohms	400 V.	—23 V.	30 W.	60 W.
1602's or 210's	8000 ohms	425 V.	—50 V.	25 W.	50 W.
801's	10000 ohms	600 V.	—75 V.	45 W.	90 W.
2-6L6's AB_2	3800 ohms	400 V.	—25 V.	60 W.	120 W.
4-6L6's AB_1	3300 ohms	400 V.	—23 V.	60 W.	120 W.
TZ20	6100 ohms	500 V.	0	40 W.	80 W.

VM-3

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
4-46's	3000 ohms	450 V.	—20 V.	50 W.	100 W.
2-6L6's AB_2	3800 ohms	400 V.	—25 V.	60 W.	120 W.
4-6L6's AB_2	1900 ohms	400 V.	—25 V.	120 W.	240 W.
RK 30's or 800's	12500 ohms	1000 V.	—55 V.	100 W.	200 W.
	6400 ohms	750 V.	—40 V.	90 W.	180 W.
35 T's	10000 ohms	1000 V.	—25 V.	125 W.	250 W.
	6600 ohms	750 V.	—35 V.	90 W.	180 W.
RK 18's	10000 ohms	750 V.	—40 V.	65 W.	130 W.
	12000 ohms	1000 V.	—50 V.	100 W.	200 W.
RK 31's	13600 ohms	1000 V.	0	110 W.	220 W.
845's AB	4600 ohms	1000 V.	—175 V.	75 W.	150 W.
	8800 ohms	1250 V.	—225 V.	105 W.	210 W.
825	8000 ohms	850 V.	—68 V.	80 W.	160 W.
756	6800 ohms	850 V.	—30 V.	100 W.	200 W.
T-20	8000 ohms	600 V.	—30 V.	50 W.	100 W.
	12000 ohms	800 V.	—40 V.	70 W.	140 W.
809's	5200 ohms	500 V.	0	60 W.	120 W.
809's	8400 ohms	750 V.	— 5 V.	100 W.	200 W.
TZ20	12000 ohms	800 V.	0	70 W.	140 W.
HK54	6000 ohms	750 V.	0	108 W.	216 W.

VM-4

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
RK 30's or 800's	12500 ohms	1000 V.	—55 V.	100 W.	200 W.
25 T's	10000 ohms	1000 V.	—35 V.	115 W.	230 W.
	12800 ohms	1250 V.	—45 V.	130 W.	260 W.
	16000 ohms	1500 V.	—60 V.	140 W.	280 W.
RK 31's	13600 ohms	1000 V.	0	110 W.	220 W.
	17000 ohms	1250 V.	0	140 W.	280 W.
203 H's 203A's or 211's	6900 ohms	1000 V.	—35 V.	200 W.	400 W.
	9000 ohms	1250 V.	—45 V.	260 W.	520 W.
838's	7600 ohms	1000 V.	0	200 W.	400 W.
	11200 ohms	1250 V.	—16 V.	260 W.	520 W.
830 B's	6000 ohms	800 V.	—27 V.	135 W.	270 W.
	7600 ohms	1000 V.	—35 V.	175 W.	350 W.
805's	6700 ohms	1250 V.	0	300 W.	600 W.
50 T's	20000 ohms	2000 V.	—180 V.	250 W.	500 W.
	15000 ohms	1500 V.	—135 V.	175 W.	350 W.
	10000 ohms	1250 V.	—125 V.	135 W.	270 W.
HK 354's	10000 ohms	1500 V.	—125 V.	280 W.	560 W.
HF-100's	7000 ohms	1000 V.	—35 V.	200 W.	400 W.
	12000 ohms	1500 V.	—52 V.	260 W.	520 W.
ZB-120's	4800 ohms	750 V.	0	150 W.	300 W.
	7000 ohms	1000 V.	0	200 W.	400 W.
	9000 ohms	1250 V.	0	245 W.	490 W.
	11000 ohms	1500 V.	— 9 V.	300 W.	600 W.
808's	13000 ohms	1250 V.	—15 V.	190 W.	380 W.
100-TH's	5200 ohms	1000 V.	0	200 W.	400 W.
	7200 ohms	1250 V.	0	250 W.	500 W.
	9600 ohms	1500 V.	—22 V.	300 W.	600 W.
100-TL's	5000 ohms	1000 V.	0	210 W.	420 W.
	10000 ohms	1500 V.	—22 V.	300 W.	600 W.
811's	15000 ohms	1250 V.	0	175 W.	350 W.
811's	18000 ohms	1500 V.	— 9 V.	225 W.	450 W.
812's	15000 ohms	1250 V.	— 36 V.	175 W.	350 W.
812's	18000 ohms	1500 V.	— 46 V.	225 W.	450 W.
TZ40	9000 ohms	1000 V.	0	150 W.	300 W.
TZ40	6900 ohms	1000 V.	0	175 W.	350 W.
HK54	12500 ohms	1500 V.	— 45 V.	200 W.	400 W.

VM-5

Modulator Tubes	Modulator Plate to Plate Load Imped.	Plate Volts	Bias Volts	AF Power Output	Class C DC Watts Input
203 H's, 203 A's or 211's	9000 ohms	1250 V.	—45 V.	260 W.	520 W.
838's	11200 ohms	1250 V.	—16 V.	260 W.	520 W.
805's	6700 ohms	1250 V.	0	300 W.	600 W.
	8200 ohms	1500 V.	—16 V.	370 W.	740 W.
203H	10000 ohms	1750 V.	—65 V.	370 W.	740 W.
	15000 ohms	2000 V.	—75 V.	450 W.	900 W.
204A or HF 300	7800 ohms	1500 V.	—40 V.	400 W.	800 W.
	8200 ohms	1750 V.	—50 V.	500 W.	1 KW.
	8800 ohms	2000 V.	—60 V.	600 W.	1200W.
	13120 ohms	2500 V.	—85 V.	650 W.	1300W.
150 T's	5000 ohms	1250 V.	—100 V.	260 W.	520 W.
	8000 ohms	1500 V.	—125 V.	350 W.	700 W.
	10400 ohms	2000 V.	—175 V.	500 W.	1 KW.
	14000 ohms	2500 V.	—225 V.	650 W.	1300W.
50 T's	20000 ohms	2000 V.	—175 V.	250 W.	500 W.
4-203A's	4500 ohms	1250 V.	—45 V.	500 W.	1 KW.
4-838's	5600 ohms	1250 V.	—16 V.	500 W.	1 KW.
4-805's	3350 ohms	1250 V.	0	600 W.	1200W.
HK 354's	15000 ohms	2000 V.	—175 V.	370 W.	740 W.
	17500 ohms	2500 V.	—225 V.	460 W.	920 W.
HF-100	16000 ohms	1750 V.	—62 V.	350 W.	700 W.
HF-200	11000 ohms	2000 V.	—92 V.	500 W.	1000W.
822	9000 ohms	2000 V.	—90 V.	500 W.	1000W.
	16000 ohms	2000 V.	—50 V.	380 W.	760 W.
100-TH	16000 ohms	2000 V.	Adj.	380 W.	760 W.
	22000 ohms	2500 V.	Adj.	460 W.	920 W.
250-TH	2360 ohms	1000 V.	0	350 W.	700 W.
	3280 ohms	1250 V.	0	540 W.	1080W.
	4200 ohms	1500 V.	—10 V.	630 W.	1260W.
810's	6600 ohms	1500 V.	— 30 V.	500 W.	1000W.

DRIVER VARIMATCH UNITS

Another application where impedance matching must be considered is in driver transformers for class AB and class B amplifiers. Since in a class B amplifier only one-half of the input transformer secondary functions at a time, impedance matching must be considered from the total primary to one-half of the secondary.

To make our analysis simple, let us assume that we have a perfect transformer of the correct ratio for the purpose intended. The impedance reflected into the grid circuit will be equal to the impedance ratio (total primary to ½ secondary) multiplied by the source impedance. It is desirable to keep this impedance as reflected in the grid circuit much lower than the impedance to which the grid is driven at high levels. That is, if our grid drops from infinity to 200 ohms at maximum output, the reflected impedance, which the transformer shows in the grid circuit, should preferably not exceed more than a fraction of this 200 ohms.

As an example, let us take the case of an amplifier using type 46 tubes, operating in class B. If we check back to a typical transformer for these tubes, we find a ratio, total primary to ½ secondary, of 3.2. Since this is the voltage ratio, it must be squared to obtain the impedance ratio, which we find to be 10. If we use a 46 driver, the source impedance would be 2380 ohms. Dividing 2380 by 10, we obtain a reflected impedance in the grid circuit of 238 ohms. **The lower we can make this impedance, the further we can drive our output tubes with low grid distortion.**

While it is possible to obtain a lower grid impedance by increasing the step down ratio of our transformer, this cannot be carried too far, as a definite amount of grid driving voltage is necessary. It is also possible to obtain the same effect by using the same transformer and changing our driver tube. Let us assume that we use the same transformer with a 2A3 tube. Since the plate impedance of this tube is approximately 800 ohms and the impedance ratio of our transformer is 10, the reflected impedance in the grid circuit would be only 80 ohms. This is much less than that obtained with the 46 driver.

The use of pentodes and other high mu tubes has been frequently recommended for class B driver service. An analysis of the above paragraphs will immediately show the fallacy of this. A typical mistake in this respect is the recommendation of the 6B5 tube as a driver for high power class B systems. Since the plate resistance of this tube is 24,000 ohms, it is readily seen that the reflected impedance will be 30 times as great as that obtainable with a 2A3 tube having 800 ohms resistance. The very high impedance which the 6B5 would reflect into the grid circuit of our class B tubes would limit their power appreciably; in some cases to less than half that obtainable by using the 2A3 tube.

The UTC Varimatch driver transformers are tapped to afford various impedance ratios so that optimum operation can be obtained for a given combination of driver and output tubes.

VARIMATCH UNITS FOR PUBLIC ADDRESS SERVICE

Tubes used in PA equipment have increased considerably in number during the past few years. It is only natural that PA amplifiers be changed over to new tubes such as the beam power tubes as they become available. To eliminate obsolescence and also for use on special PA equipment, where universal matching is essential, the UTC PA Varimatch transformers have been designed. These units have secondary impedances for voice coils and lines and have a tapped primary arrangement covering many impedance combinations.

PA VARIMATCH TRANSFORMERS

UTC PA Varimatch transformers are designed with universal tapped primaries which will match practically any PA output tubes. The available connections for the PVM 1, 2 and 3 are as follows:

Pri. Impedance	Join	Connect to
14,000 ohms	3 to 4; 6 to 7	1-5-9 (P-B-P)
10,000 ohms	2 to 4; 6 to 8	1-5-9 (P-B-P)
8,000 ohms	————	4-5-6 (P-B-P)
7,000 ohms	1 to 4	2-6 (P-B)
6,000 ohms	1 to 4; 6 to 9	2-5-8 (P-B-P)
5,000 ohms	2 to 4; 6 to 8	3-5-7 (P-B-P)
3,000 ohms	1 to 4; 6 to 9	3-5-7 (P-B-P)

Connect to	Sec. Impedance
A & D	16 ohms
A & C	8 ohms
B & D	5 ohms
A & B	3 ohms
C & D	1.5 ohms

Typical tube combinations that are taken care of by these primary impedances are:

14,000 ohms—Pushpull 47's, 2A5's, 42's, and other similar pentodes

10,000 ohms—Pushpull 59 triodes, 71A's, 6B5's, 6F6 pentodes, and Class B 6A6, 19, 53, 49, 79, 89

8,000 ohms—Pushpull 250's, 245's, 43's, 2A5 triodes, 42 triodes, etc.

7,000 ohms—Single 2A5 pentode, 42 pentode, 31 triode, 33 pentode, 47 pentode, 89 pentode

6,000 ohms—Class B pushpull 46's, 59's, 6F6's fixed bias, 6L6's AB_1, single 31, 46, 59 pentode

5,000 ohms—Pushpull self bias 2A3's, 6A3's, 6L6's at 250 volts 46's at 300 volts

3,000 ohms—Pushpull fixed bias 2A3's, 6A3's

Impedances differing somewhat from the impedances noted above can be accommodated by the primary winding. A corresponding change is obtained in the secondary output impedance. In other words, if pushpull 6L6's were used at the 400 volt operating condition, the matching impedance is 6600 ohms. The 6000 ohm connections would be used for this application with the result that all secondary impedances would be increased 10%. In other words, the 5 ohm connection would be 5.5 ohms; the 200 ohm connection, 220 ohms, etc. In a similar manner, the secondary impedances can be changed up to 30% from the normal value with a corresponding change in the primary impedance. For example, if a 6 ohm voice coil were connected across the 5 ohm taps, then the primary impedance shown would be multiplied by 6. In other words, the 5000 ohm plate

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5

to plate connection would become 6000 ohms.

LINE VARIMATCH TRANSFORMERS

UTC Line Varimatch Transformers are designed to match voice coil impedances to a 500 ohm line, where the speakers are located at some distance from the audio amplifier. The voice coil impedances available on these units range from .1 to 30 ohms, so that any speaker or group of speakers can be matched (see chart). Where speakers are to be connected in groups to one transformer, it is always preferable that parallel connection be used to eliminate the possibility of multiple resonance. It is also important to remember that if two speakers of different impedances are connected in parallel, the lower impedance speaker will develop greater power. If connected in series, the higher impedance speaker will develop greater power.

The effective impedance of a group of speakers connected to one transformer can be calculated in the following manner:

For speakers in series, add all the impedances. For example, the effective impedance of a 2 ohm and two 4 ohm speakers in series is $2 + 4 + 4 = 10$ ohms.

For identical speakers in parallel, divide the impedance of one speaker by the number of speakers used. In other words three 15 ohm speakers in parallel would have an effective impedance of $\frac{15}{3} = 5$ ohms.

For two different speakers in parallel, divide the product of their impedances by the sum of their impedances. That is, the impedance of a 4 and 12 ohm speaker in parallel would be $\frac{4 \times 12}{4 + 12} = 3$ ohms.

For a number of different speakers in parallel, add the reciprocals of the individual impedances and then take the reciprocal of this sum. If three speakers having impedances of 2, 4 and 8 ohms were connected in parallel the impedance would be $\frac{1}{1/2 + 1/4 + 1/8} = \frac{1}{.875} = 1.1$ ohms.

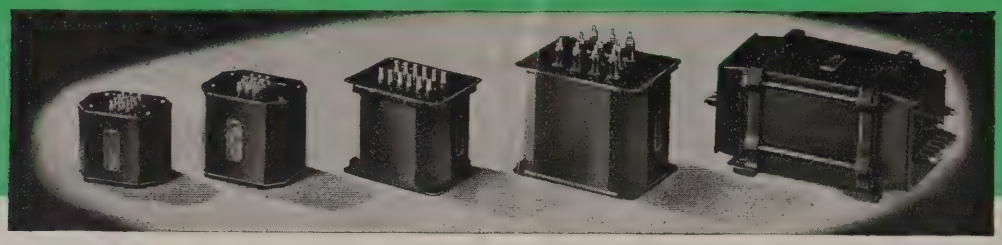
PARALLELING LINE VARIMATCH UNITS

If the individual speakers or groups of speakers are located at some distance from each other, separate Line Varimatch transformers must be used. The 500 ohm output of these units can then be connected in parallel to the amplifier. A single speaker, four speakers in series parallel, or nine speakers in three series—three parallel groups, will effect a direct 500 ohm impedance for matching to the amplifier. For other combinations, the 500 ohm outputs of the LVM units should be connected in parallel and then matched to the amplifier by using the correct tap on a Line Varimatch Autoformer unit. The autotransformer is tapped at 500, 250, 167, 125, 100, 83, 71, 62, 55, and 50 ohms for from 1 to ten 500 ohm lines in parallel respectively.

LINE VARIMATCH IMPEDANCE COMBINATIONS

Connect Voice Coil to	join	also join	Voice Coil Impedance with 500 ohms connected to A&B	Voice Coil Impedance with 500 ohms connected to B&C*	Voice Coil Impedance with 500 ohms connected to A&C
2 and 3	2 to 6	3 to 7	.4	2.5	.2
1 and 2	1 to 7	2 to 8	1.	6.25	.5
3 and 5	3 to 4	5 to 6	1.25	8.	.62
1 and 3	1 to 6	3 to 8	2.5	16.	1.25
2 and 5	2 to 4	5 to 7	3.	20.	1.5
1 and 8	2 to 7		4.	25.	2.
1 and 6	2 to 4		4.5	28.	2.25
3 and 6	4 to 5		5.	31.	2.5
1 and 8	2 to 6		6.6	40.	3.3
1 and 5	1 to 4	5 to 8	7.5	47.	3.8
2 and 6	4 to 5		8.	50.	4.
1 and 8	3 to 6		10.	63.	5.
2 and 8	3 to 4		11.	69.	5.5
2 and 7	4 to 5		12.	75.	6.
1 and 8	2 to 4		14.		7.
1 and 6	4 to 5		15.		7.5
1 and 8	5 to 6		18.		9.
2 and 8	4 to 5		20.		10.
1 and 8	4 to 5		30.		15.

* This connection gives a low frequency loss which is frequently desirable in PA work to eliminate the overloading of loud speakers with low frequency.



★ UTC VARIMATCH TRANSFORMERS

VM-0 Will handle any power tubes to modulate a 10 to 25 watt Class C stage. PA-1 ..... List Price **$6.00**

VM-1 Will handle any power tubes to modulate a 20 to 60 watt Class C stage. Maximum audio output 30 watts. PA-2 ..... List Price **$9.50**

VM-2 Will handle any power tubes to modulate a 40 to 120 watt Class C stage. Maximum audio output 60 watts. PA-3 ..... List Price **$14.00**

VM-3 Will handle any power tubes to modulate a 100 to 250 watt Class C stage. Maximum audio output 125 watts. PA-4 ..... List Price **$20.00**

VM-4 Will handle any power tubes to modulate a 200 to 600 watt Class C stage. Maximum audio output 300 watts. PA-5 ..... List Price **$35.00**

VM-5 Will handle any power tubes to modulate a 450 watt to 1 KW plus, Class C stage. Maximum audio output 600 watts. UTS ..... List Price **$80.00**

The secondaries of all Varimatch transformers are designed to carry the Class C plate current.

★ NEW VARIMATCH INPUT TRANSFORMERS

PA-51AX Single 46 or 6L6 to Class B 46 or 59 grids. Single 45, 59, 2A3 or 6L6 to Class B 46 or 59 grids. Single 49 to Class B 49 grids. Single 37, 76, 6C6 or 6C5 triode to Class B 19 or 79 grids. Single 30 to Class B 19 or 79 grids. Single 89 to Class B 19 or 79 grids. Single 2A5, 42, 45 triode plate to A prime 45's, 2A5's or 42's. PA-1 ..... List Price **$6.50**

PA-53AX Push pull 42, 45, 50, 59, 2A3 or 6L6 plates to two 210, 801, RK-18, 35T or 800 Class B grids. Push pull 2A-3 plates to two 838, 203A, 50T, 35T, 211A, 242A, 830B, 800, RK-18, 801 or 210 Class B grids. PA-2 ..... List Price **$8.00**

PA-59AX 500, 200 or 50 ohm line to two 805, 838, 203A, 830B, 800, RK-18, 801 or 210 Class B grids ..... List Price **$8.00**

PA-238AX Push pull parallel 2A3, 45, 50, 59 or 6L6 to four 805, 838, or 203A Class B grids. Push pull parallel 2A3, 45, 50, 59, 6L6 or two 211A, 845 plates to Class B 204A, HF-300 or 849 grids. Push pull parallel 2A3, 45, 50 or two 50T, 211A, 845 plates to Class B 150T or HF-200 Class B grids. PA-3. List Price **$20.00**

PA-512 500, 200 or 50 ohm line to two 150T, HF-300, HF-200, 204A or 849 Class B grids. PA-3 ..... List Price **$20.00**

★ UTC PA VARIMATCH TRANSFORMERS

PVM-1 For all audio tubes up to 12 watts audio. Output 500, 200, 15, 8, 5, 3, 1½ ohms. Some typical tubes single or push pull: 19, 31, 33, 41, 42, 43, 45, 47, 48, 49, 53, 59, 71A, 79, 89, 2A3, 2A5, 6A6, 6F6, 6V6, 25A6, 25L6. PA-1. List Price **$6.00**

PVM-2 For all audio tubes up to 30 watts audio. Output 500, 200, 16, 8, 5, 3, 1½ ohms. Some typical tubes for single, push pull, or push pull parallel: 19, 31, 33, 41, 42, 43, 45, 46, 47, 48, 49, 50, 52A, 300A, 53, 59, 71A, 79, 89, 841, 843, 1602, 2A3, 2A5, 6A6, 6F6, 6L6, 6V6, 25A6, 25L6. PA-2. List Price **$9.50**

PVM-3 For all audio tubes up to 60 watts audio. Output 500, 200, 16, 8, 5, 3, 1½ ohms. Some typical tubes in push pull parallel: 42's, 45's, 46's, 50's, 52's, 300A's, 59's, 2A3's, 2A5's, 6F6's. In push pull self or fixed bias: 6L6's, 10's, 807's 801's. PA-3 ..... List Price **$14.00**

PVM-4 For all audio tubes up to 125 watts audio. Output 500, 200, 16, 8, 5, 3, 1½ ohms. Some typical tubes push pull parallel: 6L6's, 10's, 807's, 801's, push pull 845's, 800's, etc. PA-4 ..... List Price **$20.00**

PVM-5 For all audio tubes up to 300 watts audio. Output 500, 200, 16, 8, 5, 3, 1½ ohms. Typical tubes: 211, 242A, 203A, 830B, 852, 838, 4—800's, 4—845's, ZB 120, etc. PA-5. List Price **$35.00**

★ LINE VARIMATCH UNITS

The UTC Line Varimatch Units will match any voice coil or group of voice coils to a 500 ohm line. Impedance range is from .2 to 75 ohms in 50 combinations. UTC Line Varimatch Autoformers will match one to ten 500 ohm lines or LVM 500 ohm windings to the 500 ohm output of an audio amplifier.

LVM-1 15 Watt Line Varimatch unit. 500 ohms to variable voice coil winding .2 to 75 ohms. PA-1 case. List Price **$5.50**

LVM-2 40 Watt Line Varimatch unit. 500 ohms to voice coil winding of .2 to 75 ohms. PA-2 case. ..... List Price **$8.00**

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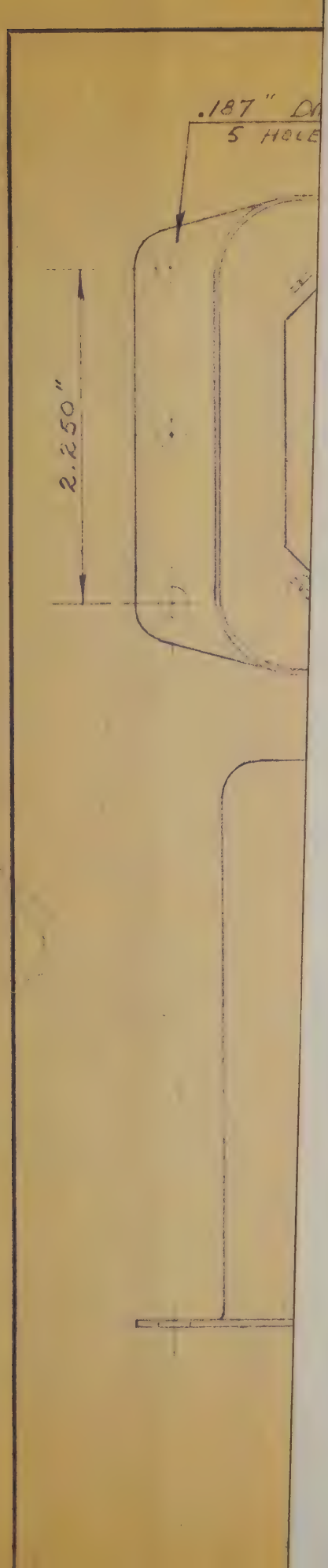
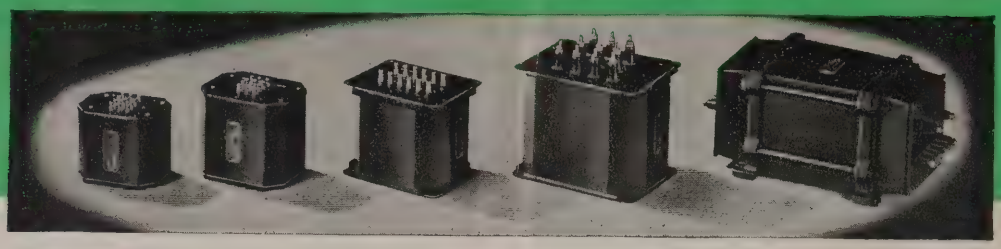
UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"


.187" DI
5 HOLE
2.250"



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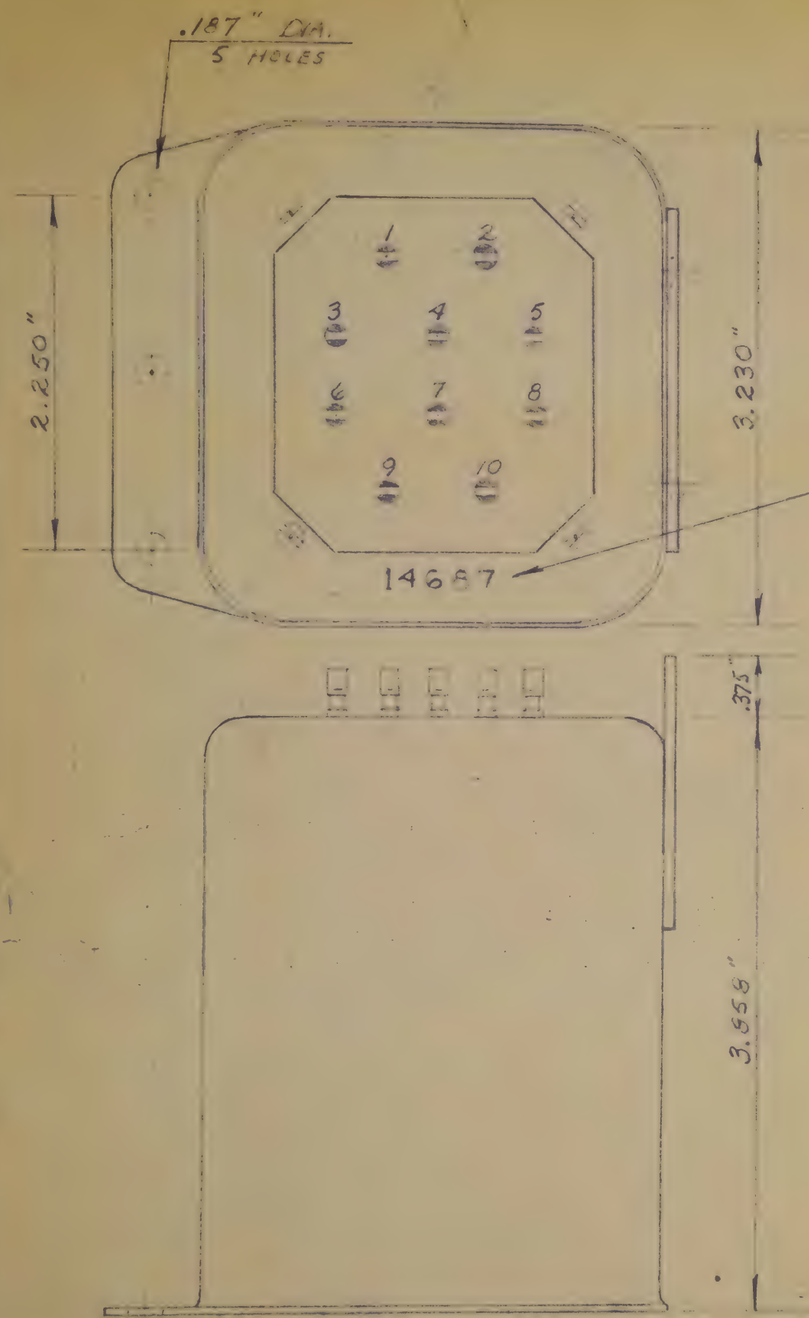
UNITED TRANSFORMER CO.

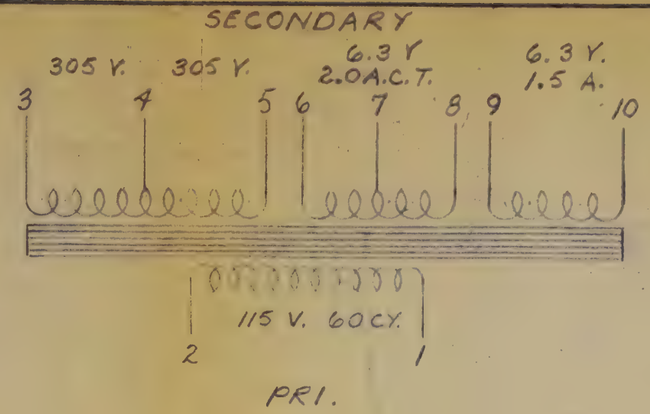
150 VARICK STREET ★ NEW YORK, N. Y.

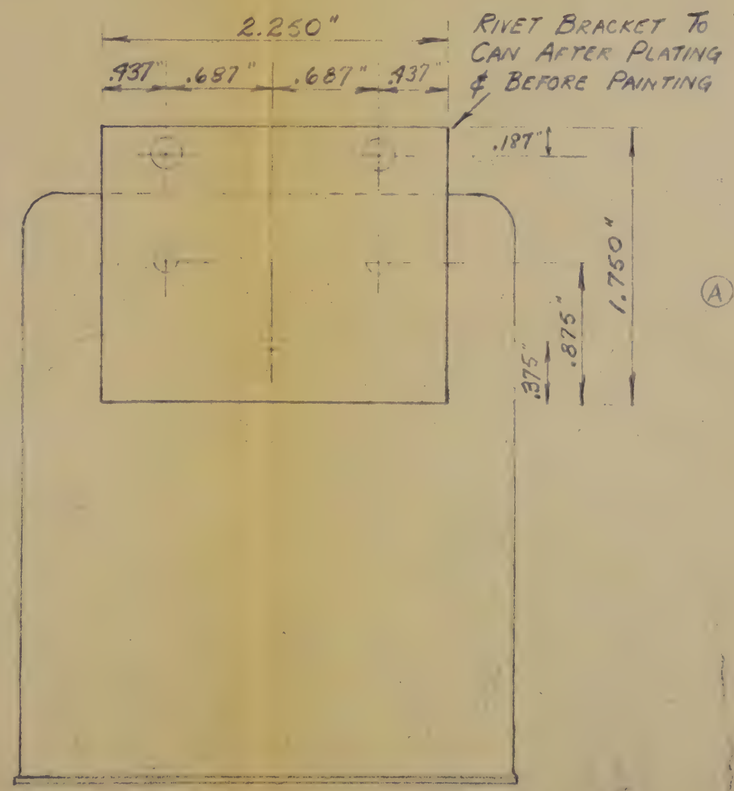
EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

NO. REQ'D	USED ON

OP-1047







SCHEMATIC

Plate Winding to deliver 135 M.A. at 305 Volts D.C. Intermittent 5 minutes on 5 minutes off using 2 6x5 GT into 3 mfd. capacitor.

Rectifier Winding to deliver 1.5 Amperes at 6.3 Volts.

Filament Winding to deliver 2.0 Amperes at 6.3 Volts.

Primary for 115 Volts 60 cycles A.C.
One (1) inch lamination 1 1/2" stack.
Chicago Transformer Corp. case type 13046 Transformer potted with Sorite No. 3

NOTES

1. Transformer core must be securely anchored to inside of case.
2. Apply glyptal cement around terminal board inside of case.
3. Solder bottom cover to case on all edges.
4. See Operadio Form 3097A for applicable specifications concerning this transformer. (A)

FINISH SPECIFICATIONS

FS-4 Tin Plate
a) .0003" min.

FS-3 Synthetic Black Enamel (Polymerizing)
b) Two coats #12412 Roxalin or equal. (each coat baked separately)

REV.	WAS	DATE
A	Alter 'A' to Form 3097	4/13/43

MATERIAL _____ FINISH _____
UNLESS OTHERWISE SPECIFIED DECIMAL DIMENSIONS TO BE ±. " FRACTIONAL DIMENSIONS TO BE ± "

OPERADIO
OPERADIO MANUFACTURING CO.
ST. CHARLES, ILL., U.S.A.

POWER TRANSFORMER
PART Nº 14687

SCALE Full		DATE 10-9-43
DRAWN E.G.C.	APP'D.	NO. T-3269-A
CHECKED	ENGR. WRT	

FORM 2256 CHARLES BRUNING CO., INC.

Type: Power
Description

Core Type &
Core Size
Interlace
Termination
Static Shie
Impregnatio
Temp.Rise
Regulation
Mounting V
External Fi

Pri.V. 1
Pri.No Load
Pri.Turns
Tapped at
NOTES:

High Voltag
780
Tap to
Electr
To Pro
Rect.
Sec.No. 2

Tap at
Sec.No. 3

Tap at
Sec.No.

Tap at
NOTES:

Breakdown:
and all oth
noted:

Pri. 2
Sec. 1 2
Sec. 2 1
Sec. 3 2
Sec.
Apply
for 1/2 min
&
ings open.

Specs.By

Could Be Used In Exciter

OPERADIO MFG. COMPANY OP No. _____

POWER TRANSFORMER SPECIFICATIONS Pt.No. 710-4043-01

Type: Power Transformer
Description Vertical Mounting

Core Type & Mat'l _____
Core Size _____ Stack _____
Interlace _____ X _____
Termination Leads
Static Shields None
Impregnation Varnish
Temp.Rise 50 °C Cont. Duty Max.Amb.Temp. _____ °C
Regulation _____ % @ Volts _____ Cycles _____
Mounting Vertical
External Finish Black enamel

Pri.V. 117 Tapped None Freq. 50-60 Cycles
Pri.No Load Current _____ Pri.Full Load Current _____
Pri.Turns _____ ± _____ % No. _____ B & S Ga. _____ Wire
Tapped at _____ Turns from Start
NOTES: _____

High Voltage Sec.No. 1
780 V.AC _____ Amp.AC _____ Turns ± _____ % No. _____ B & S Ga.Wire
Tap to produce _____ V.AC _____ Turns from Start
Electrical Center Tap - Yes - [redacted]
To Produce 415 V. DC 300 Milli Amp. DC with 2 - 5U4G
Rect. and 40 Mfd-[redacted] Input Filter Load
Sec.No. 2 6.3 Volts A.C. ± 1.0 % 5 Amps.
_____ Turns ± _____ % No. _____ B & S Ga.Wire
Tap at Center V. AC _____ Turns from Start
Sec.No. 3 5 Volts A.C. ± 1.0 % 6 Amps.
_____ Turns ± _____ % No. _____ B & S Ga.Wire
Tap at _____ V. AC _____ Turns from Start
Sec.No. ____ _____ Volts A.C. ± _____ % _____ Amps.
_____ Turns ± _____ % No. _____ B & S Ga.Wire
Tap at _____ V. AC _____ Turns from Start
NOTES: _____

Breakdown: Winding to core and all other windings as noted:

Pri. 2000 V
Sec. 1 2000 V
Sec. 2 1250 V
Sec. 3 2000 V
Sec. ____ _____ V

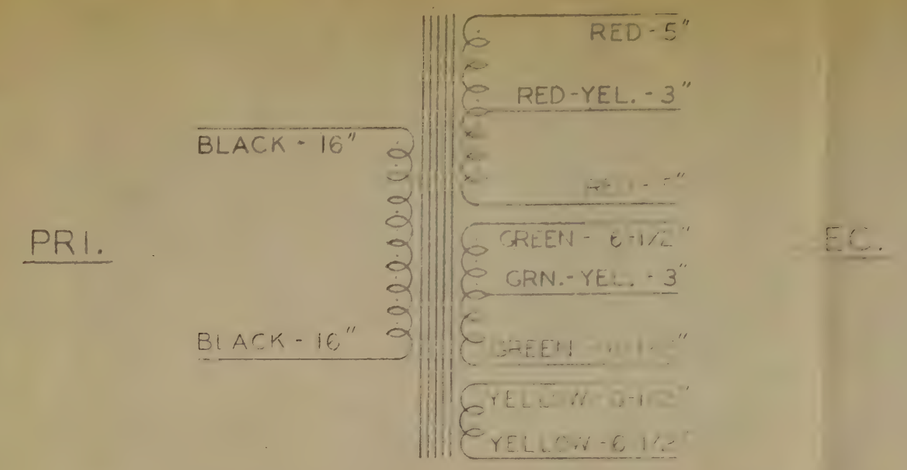
Apply _____ volts, 240 cycles for 1/2 min. between _____ & _____. All other windings open.

NOTES: _____

Specs.By _____ Approved By _____ Sample Approved _____ Date 1-3-47

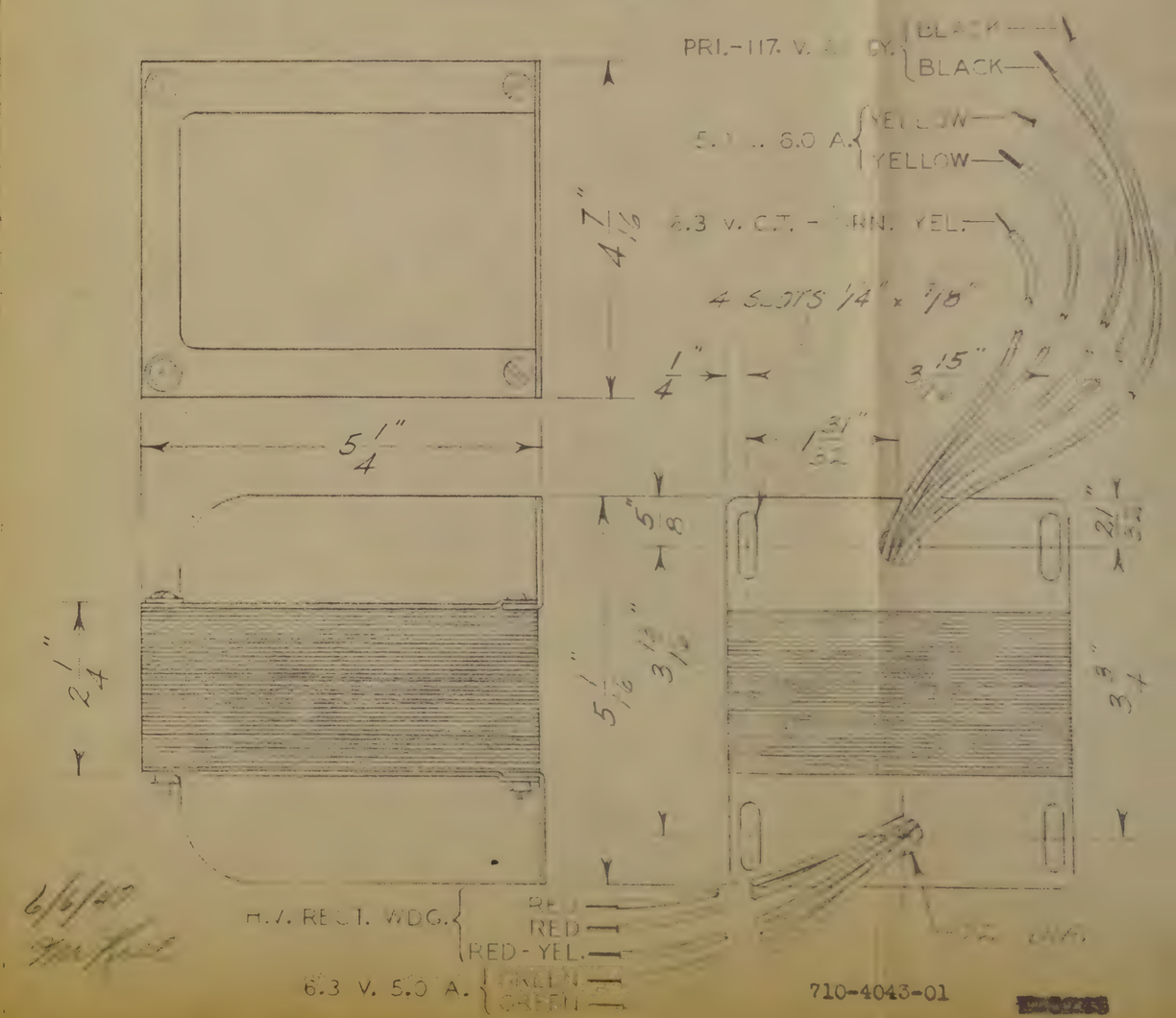
01 Rev. 6-2-47

SCHEMATIC DIAGRAM



NOTE: Lead Lengths Measured From point of emergence, including 1/2" tinned ends

PHYSICAL SPECS



6/6/47

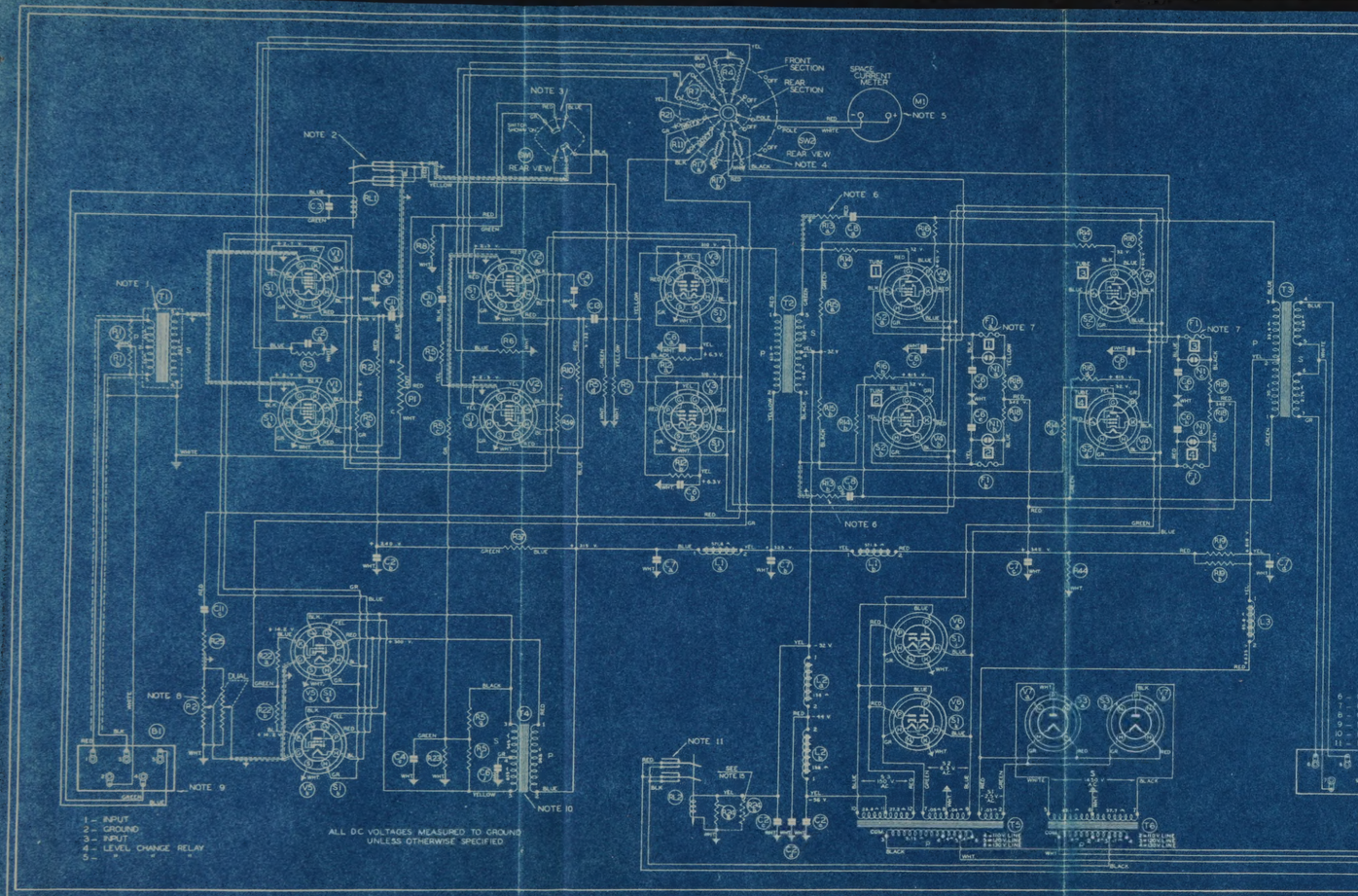
710-4043-01

LIST OF ELECTRICAL PARTS

QUANTITIES ARE FOR ONE ASSEMBLY

REF DES	NAME OF PIECE	NO. REQD	MATERIAL	MATERIAL SPECS	MANUFACTURER	MODEL NO.	REMARKS	CONT. NO.	SERIAL NO.
R1	RESISTOR 22 OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R2	RESISTOR 100,000 OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R3	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R4	RESISTOR [illegible] OHM	2	WIREWOUND	RE13A272J	PRECISION RESISTOR	[illegible]	[illegible]	[illegible]	
R5	RESISTOR [illegible] OHM	2	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R6	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R7	RESISTOR [illegible] OHM	1	WIREWOUND	RE13A272J	PRECISION RESISTOR	[illegible]	[illegible]	[illegible]	
R8	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R9	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R10	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R11	RESISTOR [illegible] OHM	1	WIREWOUND	RE13A272J	PRECISION RESISTOR	[illegible]	[illegible]	[illegible]	
R12	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R13	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R14	RESISTOR [illegible] OHM	1	WIREWOUND	RE13A272J	PRECISION RESISTOR	[illegible]	[illegible]	[illegible]	
R15	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R16	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R17	RESISTOR [illegible] OHM	1	WIREWOUND	RE13A272J	SPRAGUE SPEC. [illegible]	[illegible]	[illegible]	[illegible]	
R18	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R19	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R20	RESISTOR [illegible] OHM	1	WIREWOUND	RE13A272J	PRECISION RESISTOR	[illegible]	[illegible]	[illegible]	
R21	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R22	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R23	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R24	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R25	RESISTOR [illegible] OHM	1	WIREWOUND	RE13A272J	SPRAGUE SPEC. [illegible]	[illegible]	[illegible]	[illegible]	
R26	RESISTOR [illegible] OHM	1	CARBON	17PM	STACKPOLE	[illegible]	[illegible]	[illegible]	
R27	RESISTOR [illegible] OHM	1	WIREWOUND	RE13A272J	SPRAGUE SPEC. [illegible]	[illegible]	[illegible]	[illegible]	
C1	CAPACITOR [illegible] MFD	1	PAPER		MICAMOLD RADIO CORP	[illegible]	[illegible]	[illegible]	
C2	CAPACITOR [illegible] MFD	1	DYKANOL	RE13A448D	CORNELL DUBILIER	[illegible]	[illegible]	[illegible]	
C3	CAPACITOR [illegible] MFD	1	DYKANOL	RE13A448D	CORNELL DUBILIER	[illegible]	[illegible]	[illegible]	
C4	CAPACITOR [illegible] MFD	1	DYKANOL	RE13A448D	CORNELL DUBILIER	[illegible]	[illegible]	[illegible]	
C5	CAPACITOR [illegible] MFD	1	PAPER		MICAMOLD RADIO CORP	[illegible]	[illegible]	[illegible]	
C6	CAPACITOR [illegible] MFD	1	DYKANOL	RE13A448D	CORNELL DUBILIER	[illegible]	[illegible]	[illegible]	
C7	CAPACITOR [illegible] MFD	1	DYKANOL	RE13A448D	CORNELL DUBILIER	[illegible]	[illegible]	[illegible]	
C8	CAPACITOR [illegible] MFD	2	MICA	RE13A154D	CORNELL DUBILIER	[illegible]	[illegible]	[illegible]	
T1	FILTER REACTOR [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
T2	FILTER REACTOR [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
T3	FILTER REACTOR [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
T4	[illegible] TRANSFORMER [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
T5	[illegible] TRANSFORMER [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
T6	[illegible] TRANSFORMER [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
T7	[illegible] TRANSFORMER [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
T8	[illegible] TRANSFORMER [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
T9	[illegible] TRANSFORMER [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
K1	RELAY [illegible]	1		17PM	STRUTHERS DUNN	[illegible]	[illegible]	[illegible]	
K2	RELAY [illegible]	1	TYPE [illegible]	17PM	[illegible]	[illegible]	[illegible]	[illegible]	
P1	CONNECTOR [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
P2	CONNECTOR [illegible]	1	CARBON	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
F1	FUSE [illegible]	1	[illegible]	17PM	[illegible]	[illegible]	[illegible]	[illegible]	
M1	METER [illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	1	[illegible]		[illegible]	[illegible]		[illegible]	
SW1	SWITCH [illegible]	1		[illegible]	[illegible]	[illegible]		[illegible]	
SW2	SWITCH [illegible]	1		[illegible]	[illegible]	[illegible]		[illegible]	
SW3	SWITCH [illegible]	1			[illegible]	[illegible]		[illegible]	
T1	TERMINAL [illegible]	2	METAL	RE13A134D					
T2	TERMINAL [illegible]	1	METAL	RE13A134D					
T3	TERMINAL [illegible]	1	METAL	RE13A134D					
T4	TERMINAL [illegible]	1	METAL	RE13A134D					
T5	TERMINAL [illegible]	1	METAL	RE13A134D					
T6	TERMINAL [illegible]	1	METAL	RE13A134D					
T7	TERMINAL [illegible]	1	METAL	RE13A134D					
T8	TERMINAL [illegible]	1	METAL	RE13A134D					
[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	1	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	1	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	1	BAKELITE	[illegible]	MICAMOLD [illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	1	BAKELITE	[illegible]	MICAMOLD [illegible]	[illegible]	[illegible]	[illegible]	

FIG. 7.8 PLAN NO. 8-31MA-IV SCHEMATIC DIAGRAM - POWER AMPLIFIER - MODEL 16-1224



GENERAL NOTES: THIS MODEL NB-326A AMPLIFIER ASSEMBLY IS A COMPLETE AND SELF-CONTAINED AUDIO FREQUENCY POWER AMPLIFIER. IT HAS SUFFICIENT GAIN TO FULLY AMPLIFY THE OUTPUT OF A MODEL RE-150F PORTABLE MICROPHONE (OR EQUIVALENT MICROPHONE) AND SUFFICIENT AUDIO POWER TO DRIVE A QUANTITY OF NAVY REPRODUCERS AS REQUIRED BY SHIPYARD SPECIFICATIONS. IT IS DESIGNED FOR USE AS AN MCC AMPLIFIER IN CHANNEL "A" AND "B" POSITIONS (NAVY MC CIRCUITS) AND FOR MCR SYSTEMS (NAVY TMC CIRCUITS).

GENERAL AMPLIFIER DATA:

(a) 50 DB POWER GAIN WITH FULL COMPRESSION OR WITH COMPRESSION SWITCHED OFF

(b) MAXIMUM COMPRESSION ADJUSTABLE BY 20 DB

(c) FULL COMPRESSION TIME LESS THAN .08 SECOND

(d) POWER OUTPUT 125 WATTS WITH 3% TOTAL HARMONIC DISTORTION
1870 A RESISTIVE LOAD

(e) POWER OUTPUT 150 WATTS WITH 10% TOTAL HARMONIC DISTORTION
1870 A RESISTIVE LOAD

(f) INPUT IMPEDANCE 30-50 OHMS

(g) OUTPUT IMPEDANCE 200 OHMS

(h) AMPLIFIER CHARACTERISTICS WITH NO COMPRESSION

DOWN	25 DB AT	100 CYCLES
DOWN	2 DB AT	500 CYCLES
DOWN	0.5DB AT	1,000 CYCLES
UP	1 DB AT	2,000 CYCLES
UP	1.5 DB AT	4,000 CYCLES
DOWN	1+1/2 DB AT	5,000 CYCLES
DOWN	4 DB AT	6,000 CYCLES
DOWN	8 DB AT	8,000 CYCLES

(i) AMPLIFIER CHARACTERISTICS WHEN ADJUSTED FOR 18-20 DECIBELS COMPRESSION AT RATED OUTPUT OF 125 WATTS:

DOWN	30 DB AT	75 CYCLES
DOWN	4 DB AT	100 CYCLES
DOWN	2 DB AT	125 CYCLES
DOWN	2 DB AT	500 CYCLES
DOWN	2 DB AT	1,000 CYCLES
DOWN	4 DB AT	2,000 CYCLES
DOWN	7 DB AT	3,000 CYCLES
DOWN	9 DB AT	4,000 CYCLES
DOWN	9 DB AT	5,000 CYCLES
DOWN	10 DB AT	6,000 CYCLES

(j) POWER REQUIREMENTS - 90-120 VOLTS 60 CYCLE AC (SINGLE PHASE)
STANDBY - 90 WATTS - .998 P.F. LAGGING
READY - 450 WATTS - .969 P.F. LAGGING

NOTES

1 - INPUT TRANSFORMER - METTED IN MULTIPLE ALLOY MESTING SHIELDS

2 - LEVEL CHANGING RELAY - OPERATED BY EXTERNAL CONTROL CIRCUIT IN CONJUNCTION WITH SIGNAL GENERATORS. CUTS OUT COMPRESSION STAGE AND VOLUME CONTROL CIRCUITS WHEN ALARM SIGNALS ARE SOUNDED, PROVIDING PRE-DETERMINED AND CONSTANT OUTPUT LEVEL FROM AMPLIFIER TO ALL CONNECTED REPRODUCERS.

3 - COMPRESSION SWITCH - PROVIDES MANUAL CUT-OUT OF COMPRESSION STAGE FROM AMPLIFIER CIRCUITS. (VOLUME CONTROL REMAINS EFFECTIVE.)

4 - METER SWITCH - INDICATES SPACE CURRENT METER IN CATHODE CIRCUITS OF ALL AMPLIFIER TUBES (INCLUDING RECTIFIERS). JUMPERS RESISTORS SHOWN WIRED BETWEEN CONNECTING LUGS ON TRUNK AND DECK SECTION OF SWITCH. REAR SECTION SHOWN PICTORIALLY.

CATHODE CURRENT FOR TUBE TYPES USED DIFFERS GREATLY. IN ORDER TO PRODUCE A SIGNIFICANT CHANGE IN THE NORMAL METER READING WHEN "RECTIFIED" DOCOM, IT WAS DEEM NECESSARY TO INSERT METER IN CATHODE CIRCUITS AS FOLLOWS:

RELAY NO. 1	RCA27 NO. 1 AND 2	
RELAY NO. 2	RCA7 NO. 1 AND 2	
RELAY NO. 1	RCA7 NO. 1 AND 2	
RCA7 NO. 2	RCA7 NO. 3 AND 4	

5 - DC MILLIAMMETER (MAY HAVING SCALE MARKED ARBITRARILY NORMAL OR ABNORMAL SPACE CURRENT (PLATE CURRENT IN CATHODE CIRCUITS) FOR ALL TUBES, AS WELL AS DEGREE OF COMPRESSION WHICH OCCURRED IN EITHER RCA7 TUBE CIRCUITS WITH AVERAGE AUDIO FREQUENCY SIGNAL FED INTO AMPLIFIER. (SEE INSTRUCTION BOOK FOR FULL DETAILS.)

6 - ELEMENTS R18A, C8A, R19A AND C8B IN NOTE 6 ARE PUSH-PULL OUTPUT STAGE PROVIDE DEGENERATIVE FEEDBACK TO STABILIZE CIRCUIT AND SUPPRESS SUPERSONIC AND TRANSIENT HIGH VOLTAGE SIGNAL SURGES.

7 - NETWORKS CONTROLLING FUSES F1A, B, C, D1 AND NEON SIGNAL INDICATORS NI1A, B, C, D1 IN ALL FOUR SCREEN SUPPLY CIRCUITS TO ELEMENTS C4 OF THE BOT TUBES AFFORD POSSIBLE PROTECTION AGAINST AMPLIFIER FAILURE. MOST COMMON CAUSE OF OUTPUT STAGE FAILURE WHEN UNPOWERED FROM POWER FUSES TO SCREEN-TO-DEFLECTION SHORTS. (DEFLECTION IS TIED INTERNALLY TO CATHODE.) ORDINARILY A SCREEN SHORT OCCURRING IN A PUSH-PULL OUTPUT STAGE REDUCES ALL SCREEN VOLTAGES TO ZERO, CAUSING POWER FUSES TO CLEAR AMPLIFIER. (FULL PLATE SUPPLY VOLTAGE WOULD THEN OVERLOAD SCREEN GRAPHITE BECAUSE OF LOSS R19 & R20. HOWEVER, SCREEN ELEMENT "SHORTS" OCCURRING ON ONE OR EVEN TWO TUBES IN CIRCUIT APPEARING ON THIS PLAN, INDICATE "SLOWER" OVERLOADS. AMPERE FUSE F1 AND LIGHTS NEON INDICATOR NI WILL NO INTERRUPTION OF AUDIO SIGNAL TO CONNECTED LOUDSPEAKER GROUPS AT SLIGHT REDUCTION IN POWER OUTPUT. FUSES SHOW CAN BE REPLACED AT WILL AFTER DEMONSTRATING INDICATED DEFECTIVE POWER TUBE(S).

8 - CONTINUOUSLY VARIABLE TWIN ELEMENT POTENTIOMETER USED FOR ADJUSTING DEGREE OF COMPRESSION (RARELY NECESSARILY REQUIRED AFTER SOUND LEVEL FROM SPEAKERS IS DETERMINED. SEE INSTRUCTION BOOK FOR FULL DETAILS.)

9 - INPUT AND LEVEL CHANGING RELAY CONNECTIONS TO AMPLIFIER. CANNON TYPE PIN JACK CONNECTOR STRIP ENGAGES FEMALE CONNECTOR WIRED TO REMAINDER OF SIGNAL AND CONTROL CIRCUITS IN EACH AMPLIFIER ASSEMBLY.

10 - PUSH-PULL TRANSFORMER REQUIRED FOR COUPLING TO DIODE RECTIFIER ELEMENTS IN RCA7 TUBES TO PRODUCE INSTANTANEOUS GRID BIAS. DIODES APPLY VARIABLE DC BIAS VOLTAGE TO GRIDS (SEE OF RCA7'S) IN VOLUME COMPRESSOR STAGE.

11 - RELAY 18 FIXED BIAS SUPPLY CIRCUIT FOR GRIDS OF BOT POWER TUBES. PROVIDES CUTOFF FOR PLATE SUPPLY TRANSFORMER IN CASE BIAS SUPPLY FAILS. PROVIDES 20-30 SECOND TIME DELAY IN APPLICATION OF AC HIGH VOLTAGE TO PLATES OF OM6-A RECTIFIERS BY EXTERNAL SWITCHES TO PLATE AND FILAMENT TRANSFORMER ARE ENERGIZED SIMULTANEOUSLY.

12 - OUTPUT AND AC CONNECTIONS TO AMPLIFIER.

13 - "PLATE VOLTAGE DISCONNECT" SWITCH USED FOR CUTTING OFF BOTH SIDES OF AC LINE TO PLATE TRANSFORMER BEFORE AMPLIFIER CHASSIS IS OPENED FOR SERVICING.

14 - POWER TUBES ASSOCIATED NEON INDICATORS AND FUSES NUMBED [illegible] AND [illegible] ON THIS PLAN, SHOW THE CIRCUIT POSITION OF BOT POWER TUBES, NEON INDICATORS AND FUSES NUMBED WITH IDENTICAL NUMBERS ON THE AMPLIFIER CHASSIS.

15 - A SECOND RESISTOR, R24A, IS ADDED ACROSS THE RELAY PLA ON SOME AMPLIFIERS. THIS RESISTOR IS ADDED TO COMPENSATE FOR VARIATIONS IN RESISTANCE OF THE RELAY COIL, ONE REACTANCE COIL L1B AND L2B, AND TRANSFORMER T3, DUE TO COMMERCIAL TOLERANCES.

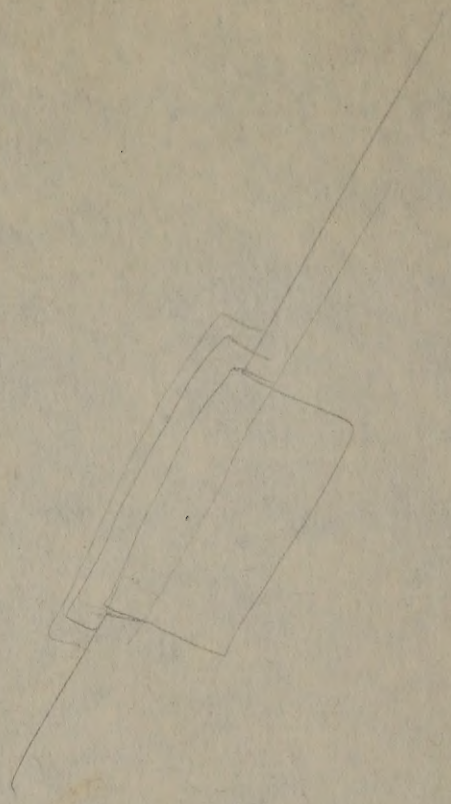
Dusty McDermaid

LIST OF ELECTRICAL PARTS

QUANTITIES ARE FOR ONE ASSEMBLY

REF DES NO	NAME OF PIECE	NO REQ'D	MATERIAL	MATERIAL SPEC'S	MANUFACTURER	MFG'RS NO.	REMARKS	CONT'D NO	BUREAU CODE NO	NAVO NO
R1	RESISTOR 20 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R2	RESISTOR 100,000 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R3	RESISTOR 1,500 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R4	RESISTOR 1,000 OHM	1	WIREWOUND	RE1340/2	PRECISION RESISTOR	TYPE PW	ONE WATT			17B7
R5	RESISTOR 510,000 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R6	RESISTOR 510 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R7	RESISTOR 1.5K OHM	1	WIREWOUND	RE1340/2	PRECISION RESISTOR	TYPE PW	ONE WATT			17B7
R7	RESISTOR 500,000 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R8A	RESISTOR 240,000 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R10	RESISTOR 51,000 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R11	RESISTOR 3 OHM	1	WIREWOUND	RE1340/2	PRECISION RESISTOR	TYPE PW	ONE WATT			17B7
R12	RESISTOR 1,500 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R13	RESISTOR 90,000 OHM	1	CARBON	17B9	STACKPOLE	RC-2	TWO WATTS			17B7
R14	RESISTOR 10 OHM	1	WIREWOUND	RE1340/2	SPRAGUE SPEC.	TYPE PW	FIFTEEN WATTS			17B7
R15	RESISTOR 4,100 OHM	1	CARBON	17B9	STACKPOLE	RC-1	ONE WATT			17B7
R16	RESISTOR 50 OHM	1	WIREWOUND	RE1340/2	SPRAGUE SPEC.	TYPE PW	TEN WATTS			17B7
R17	RESISTOR 2.5 OHM	1	WIREWOUND	RE1340/2	PRECISION RESISTOR	TYPE PW	ONE WATT			17B7
R18	RESISTOR 100 OHM	1	WIREWOUND	RE1340/2	SPRAGUE SPEC.	TYPE PW	FIVE WATTS			17B7
R19	RESISTOR 3,000 OHM	1	WIREWOUND	RE1340/2	SPRAGUE SPEC.	TYPE PW	FIFTEEN WATTS			17B7
R20	RESISTOR 36,000 OHM	1	CARBON	17B9	STACKPOLE	RC-2	ONE WATT			17B7
R21	RESISTOR 11.5 OHM	1	WIREWOUND	RE1340/2	PRECISION RESISTOR	TYPE PW	ONE WATT			17B7
R22	RESISTOR 500 OHM	1	CARBON	17B9	STACKPOLE	RC-7	ONE WATT			17B7
R23	RESISTOR 6,800,000 OHM	1	CARBON	17B9	STACKPOLE	RC-2	ONE WATT			17B7
R24	RESISTOR 1,000 OHM	1 (OPT.)	WIREWOUND	RE1340/2	SPRAGUE SPEC.	TYPE PW	ONE WATT			17B7
R25	RESISTOR 300,000 OHM	1	CARBON	17B9	STACKPOLE	RC-2	ONE WATT			17B7
R26	RESISTOR 9,750 OHM	1	WIREWOUND	RE1340/2	SPRAGUE SPEC. CO.	TYPE PW	FIFTY WATTS			17B7
C1	CAPACITOR 5000 MFD.	1	PAPER		MECHANOLYTIC CORP.	MOD. N.S.B.C.				2B4B
C2	CAPACITOR .5 MFD.	1	CERAMIC	RC34A4B0	CORNELL DUBILIER	TYPE-6500	MOD. N.V.B.C.			2B7B3
C3	CAPACITOR .5 MFD.	1	CERAMIC	RC34A4B0	CORNELL DUBILIER	TYPE-6500	MOD. N.V.B.C.			2B7B3
C4	CAPACITOR .5 MFD.	1	CERAMIC	RC34A4B0	CORNELL DUBILIER	TYPE-6500	MOD. N.V.B.C.			2B7B3
C5	CAPACITOR 5000 MFD.	1	PAPER		MECHANOLYTIC CORP.	MOD. N.S.B.C.				2B4B
C6	CAPACITOR .5 MFD.	1	CERAMIC	RC34A4B0	CORNELL DUBILIER	TYPE-6500	MOD. N.V.B.C.			2B7B3
C7	CAPACITOR .5 MFD.	1	CERAMIC	RC34A4B0	CORNELL DUBILIER	TYPE-6500	MOD. N.V.B.C.			2B7B3
C8	CAPACITOR 5000 MFD.	2	MICA	RS19B1B0/	CORNELL DUBILIER	MIDI-3-5000	MOD. M.V.B.C.			2B7E1
L1	FILTER REACTOR (POTTED)	2		RE1917/2B4A	CHI. TRANS. CORP.	CP-1040				2B7B
L2	FILTER REACTOR (POTTED)	1		RE1917/2B4A	CHI. TRANS. CORP.	CP-1041				2B7B
L3	FILTER REACTOR (POTTED)	1		RE1917/2B4A	CHI. TRANS. CORP.	CP-1042				2B7B
T1	INPUT TRANSFORMER (POTTED)	1		RE1917/2B4A	CHI. TRANS. CORP.	CP-1041				2B7B
T2	DRIVER TRANSFORMER (POTTED)	1		RE1917/2B4A	CHI. TRANS. CORP.	CP-1042				2B7B
T3	OUTPUT TRANSFORMER (POTTED)	1		RE1917/2B4A	CHI. TRANS. CORP.	CP-1043				2B7B
T4	INTERSTAGE TRANSFORMER (POTTED)	1		RE1917/2B4A	CHI. TRANS. CORP.	CP-1039				2B7B
T5	FILAMENT TRANSFORMER (POTTED)	1		RE1917/2B4A	CHI. TRANS. CORP.	CP-1044				2B7B
T6	PLATE SUPPLY TRANSFORMER (POTTED)	1		RE1917/2B4A	CHI. TRANS. CORP.	CP-1045				2B7B
RL1	RELAY D.P.D.T. SHIELDED	1		17B9	STRUTHERS DUNN	KA2B4-1A	DAYACCOM.			17B9
RL2	RELAY D.P.D.T.	1	TYPE JD-NR	17B9	CONTROL MAGNETS	CM-275	24V DC COIL			17B9
P1	POTENTIOMETER 250 W OHM	1		RE1340/2	UNITED RESIS. CO.	TYPE RD	VOLUME			17B9
P2	POTENTIOMETER DUAL 100 W OHM	1	CARBON	RE1340/2	CENTRALAB	RADIOHM	COMPRESSION			17B9
F1	FUSE 0.1 AMPERE	4	HEAVY TYPE GT	17F2	LITTELFUSE	3AG	1/4" x 1 1/4" DIA.			17B8
M1	METER 0-1 M.A. D.C.	1	2" BRASS CASE	17L128	SIMPSON	MODEL 195	SERIES DUAL			17B12
NI	NEON BULBS FUSE INDICATOR	4	GLASS		LITTELFUSE	FUSE				17B8
SW1	SWITCH 1 POLE 2 POS. 1 MOTION	1		17B4-1B9	CENTRALAB	1T101				17B4
SW2	SWITCH 1 POLE 16 POS. 2 MOTION	1		17B4-1B9	CENTRALAB	1T101				17B4
SW3	SWITCH D.P.D.T.	1			ARTLER HAMMER	6B23-1A				17B12
V1	VACUUM TUBE 6SJ7	2	METAL	RE3B4-1B4						
V2	VACUUM TUBE 6SK7	1	METAL	RE3B4-1B4						
V3	VACUUM TUBE 6K7	2	METAL	RE3B4-1B4						
V4	VACUUM TUBE 6K7G	4	GLASS	RE3B4-1B4						
V5	RECTIFIER TUBE 5X4GTA/G	2	GLASS	RE3B4-1B4						
V6	VACUUM TUBE 866-A	2	GLASS	RE3B4-1B4						
C1	METAL TUBE SOCKET	15	METAL PLUGS BAKELITE	1-KEY NO. 1	TUBE NOTE AND PHENOLIC	1B2B2	TYPE 5B8M			17B2B
C2	FINE CONTACT SOCKET	9	CERAMIC		JAN. PHENOLIC	1B2B2	TYPE 5B-3			17B2B
C3	FINE CONTACT SOCKET	1	CERAMIC		JAN. PHENOLIC	1B2B2	TYPE 5B-3			17B2B
S1	TERMINAL STRIP	1	BAKELITE	17P2	MICARTA FAB. INC.	1B5B2-B	TYPE F8			1B8B2-B
S2	TERMINAL STRIP	1	BAKELITE	17P2	MICARTA FAB. INC.	1B5B2-B	TYPE F8			1B8B2-B

FIG. 7-8 PLAN NO. 7-51454-1 SCHEMATIC DIAGRAM - POWER AMPLIFIER - MODEL NB-326A



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